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REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XII.

THE REPTILES OF EASTER ISLAND.

By Samuel Garman.

With One Plate.

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No. 1. — *Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of* ALEXANDER AGASSIZ, *by the U. S. Fish Commission Steamer "Albatross," from October*, 1904, *to March*, 1905, *Lieutenant Commander* L. M. GARRETT, U. S. N., *Commanding.*

XII.

The Reptiles of Easter Island.

By SAMUEL GARMAN.

To give an approximately complete idea of the Herpetology of Easter Island it is necessary to consider and to introduce provisionally into our list of species a number of marine tortoises and a sea serpent, which range throughout Polynesia and the tropical and the temperate portions of the Pacific and the Indian oceans, but which have not yet been taken or known directly from the island by the scientist. The snake has the better claim to attention, having been secured a short distance from the shores and positively determined. The tortoises, of which our knowledge depends wholly upon tradition or other evidence of the natives, cannot be satisfactorily identified, and if they might be, they would add little or nothing in answer to questions relating to the origin or the evolution of the fauna. This leaves as the main dependence in this study two species of small lizards, a third and larger one, the existence of which is asserted by the islanders, having, if it exists, escaped capture. From the material gathered it appears that these lizards were not originally derived from the nearer islands to the westward, in the direction of Samoa and the Fijis, but from the Hawaiian Islands to the far northwestward. We can go no farther until possessed of more material. That the Hawaiian Islands and Easter Island may both have obtained the species from some other locality is possible, but of that we have as yet no proof, while it can be said that the affinities of the species from the two localities are markedly direct. Drifting from one to the other being put aside as improbable, Hawaiian lizards may have been carried to Easter Island in several ways; they may have been landed from some vessel passing, toward the straits or to round the Cape, on its way to the Atlantic, — as we suppose some of the same species have been taken to both western and eastern coasts of South America, — in times more recent than the arrival of the islanders now in occupancy, or the saurians may have been brought with the natives when they came. Ethnologists having failed, so far, to determine the original home of the people from racial characteristics and language, or from their art as seen in the sculptures, and tablets, etc., the hypothesis is permissible, from even so attenuated a thread of evidence as that supplied by the reptiles, that when the men came the lizards came with them. Beyond this it might be possible to account at once for the undifferentiated condition of the species and for the lack of energy and of art in the present inhabitants of Easter Island by a further supposition that the makers of the images and the tablets were swept away by the latest eruption of the volcano, and that their successors with the lizards are the result of a subsequent migration from the Hawaiian Islands or thereabout, an indirect route for the reptiles, as for man, from central Polynesia.

At the first glance various features of Easter Island combine to make the study of its fauna appear to be one of particular attractiveness to the naturalist: such are position, origin, isolation, extent, diversity, and climate; it lies near the middle of the South Pacific (Lat. 27° 10′ S.; Lon. 109° 26′ W.); it originated as a volcano, without connection with other land; it has an area of about thirty-four square miles; it possesses plains, hills, and mountains (to 1700 feet), and it is covered with vegetation. A sense of disappointment comes upon one when in the course of his investigations he realizes how much the island lacks age, that its birth has been too recent for the evolution of species and varieties in a fauna of its own, when he decides that what is possessed it has borrowed in times not very remote and that he must direct his attention to the route by which it was brought. Possibly more than one start was made by flora and fauna to be destroyed by later activity of the expiring volcano; at any rate eruptive evidences confine the natural history within comparatively narrow limits of time. All of the literary history is decidedly new; it begins with Davis's alleged discovery, 1686, though the little he contributes to knowledge is not positively located and may have pertained to some other islet. Roggewein, April 7, 1722, discovered the island, named it, and furnished a general description with some information concerning people and customs. That the early writers say nothing about reptiles is not to be interpreted as if owing to non-existence but merely to non-observance; several of their statements are repeated here. Why the tortoises should have escaped their notice so completely does not appear; shells and skulls are always in evidence where tortoises are consumed. Captain James Cook, 1774, in his second voyage, gives many details relating to the island and its inhabitants. In regard to the forests the condition apparently had become worse. His men saw "not an animal of any sort and but very few birds." "They have a few tame fowls, such as cocks and hens, small but well tasted. They have also rats, which, it seems, they eat; for I saw a man with some dead ones in his hand; and he seemed unwilling to part with them, giving me to understand they were for food. Land birds there were hardly any; and sea birds but few; these were, men of war, tropic, and egg birds, nodies, tern, &c. The coast seemed not to abound with fish; at least we could catch none with hook and line, and it was but very little we saw amongst the natives." Vol. I, p. 288. La Pérouse, 1786, made additions to the fauna in the sheep, goats, and pigs he left. He says: "La côte m'a paru peu poissonneuse, et je crois que presque tous les comestibles de ces habitans sont tirés du règne végétal." Beechey, who visited the island in 1825, like his predecessors, found the people and their sculptures of first interest. He decided that the natives were "allied in language and customs to many islands in the South Sea," in none of which were such images. He tells us there was not a quadruped on the island in Roggewein's time, and adds, "nor has any one except the rat ever been seen there," Vol. I, p. 56. When discovered, the island is said to have "abounded in woods and forests, and palm branches were presented as emblems of peace; but fifty years afterwards, when visited by Captain Cook, there were no traces of them left." What is known of the fauna through the early literature contains nothing satisfactory on the herpetology. In Thomson's narrative, 1891 in the Smithsonian Report for 1889, there is matter of more pertinence. This article has more general information than those which preceded it. From it we get a better idea of the plant and animal life. Of animals there were on the island at this time, according to this author, neat cattle, rough little horses, many sheep, some rats, a few large and wild cats, some dogs, and some domestic fowls. "There are no quadrupeds peculiar to the island except several varieties of rodents." No small land birds, "only the tropic or man-of-war bird, petrels, gulls, and a variety of aquatic birds." The following concerning the fishes is quoted in contrast with the statements of Cook and La Pérouse: "Fish has always been the principal means of support for the islanders, and the natives are exceedingly expert in the various methods of capturing them. The bonito, albicore, ray, dolphin, and porpoise are the off-shore fish most highly esteemed, but the swordfish and shark are also eaten. Rock-fish are caught in abundance and are remarkably sweet and good. Small fish of many varieties are caught along the shore, and the flying-fish are common. Eels of immense size are caught in the cavities and crevices of the rock-bound coast. Fresh-water fish are reported to exist in the lakes inside of the craters, but we did not see any of them." Of particular interest in the present writing are the statements concerning tortoises. The author does not explain why he classes them with his fishes rather than his reptiles. "Turtles are plentiful and are highly esteemed; at certain seasons a watch for them is constantly maintained on the sand beach. The turtle occupies a prominent place in the traditions, and it is frequently represented in the hieroglyphics and also appears on the sculptured rocks." Other notice occurs in the translations of the tablets: "What power has the Great King on the land? He has the power to clothe the turtles in hard shell, the fish with scales, and protects every living thing. All hail the power of the Great King who enables us to overcome the defense of the turtles, fish, and all reptiles." Elsewhere it is said that Hotu-Matua and his three hundred, arriving on the island, from land to the eastward, subsisted for the first three months entirely upon fish, turtle, and the nuts of a creeping plant found growing along the ground. And in the account of Machaa's arrival with six companions, two months before Hotu-Matua, we learn that on the second day after arriving this party found a turtle on the beach near Anekena, and one of the men was killed by a blow of its flipper in trying to turn it over. At the point Ahuakapu, Mr. Thomson says, "Upon the extreme point we found another one of those round towers, built for the purpose of observing the movements of turtles on the beach." Concerning other reptiles an item is given on page 459: "Small lizards are frequently seen among the rocks; the natives claim that a large variety is not uncommon, but we saw nothing of it. No snakes exist." Small reptiles, no doubt, would find food in the several varieties of butterflies, the myriads of troublesome flies, the fleas that were worse than the flies, the mosquitoes about the water tanks, the cockroaches two inches long with antennae to correspond, infesting every house on the island, and the peculiar variety of snapping beetle which "made its appearance every evening just before sundown, appearing suddenly and vanishing with daylight," and which compelled other visitors to stuff their ears with paper.

Confining attention exclusively to the reptiles, it is found that besides the snake and the lizards collected by the "Albatross" there are five or six that may reasonably be expected to figure in later reports. Of these the larger not uncommon variety of lizard is the most indefinite and uncertain. The other four or five are marine tortoises. What is known of the wanderings of these creatures leads to anticipation of the discovery of any or all of the species of the Central Pacific at one time or another on Easter Island. Apparently the notices quoted above indicate that by one or more of the species the island has been adopted as a breeding-place, and that the return to it is regular at a particular season of the year. Unless there are grassy feeding-places near enough in the vicinity the species of the genus Chelonia will probably not be of the regular visitors but of the erratic and accidental. In compiling the list of species to be expected, those recently described from the Chilian coasts by Dr. Philippi have not been introduced, one reason being that they have not been sufficiently distinguished from the species of the Middle Pacific, and another being the unlikelihood of any species crossing from the South American shores through the Humboldt current, 900 miles in width, setting to the northward, and the additional 1200 miles of barren, comparatively foodless waters, pointed out by Mr. Alexander Agassiz, making more than 2000 miles separating the continent and the Galapagos islands, on east and north, from Easter Island. Atlantic species of these tortoises have not yet been shown to be able to pass either Magellan's Strait or south of the Cape, while it is to be expected that species from the Panamic region work their way southward along the coasts of America, reasons both for hesitation in regard to acceptance of Dr. Philippi's species as different from the Polynesian species until proved to be distinct by close comparisons.

Including the tortoises, the Easter Island Reptilia belong to the Chelonia, the Ophidia, and the Sauria.

CHELONIA.

DERMOCHELIDAE.

Dermochelys schlegelii.

TRUNK OR LEATHER BACK.

Sphargis mercurialis Temm. & Schl., Fauna Jap. Rept., 1838, p. 10.
Sphargis schlegelii Garman, Bull. 25 U. S. Mus., 1884, 292, 303.

This species ranges from Japan southward in the Pacific and the Indian oceans. *Sphargis angustata* Philippi may on comparison prove to belong to this species; it is more likely to be thus than that the Atlantic species should pass the straits of Magellan.

CHELONIIDAE.

Caretta olivacea.

LOGGERHEAD.

Chelonia olivacea Eschscholtz, Zoöl. Atlas, 1829, pt. 1, p. 3, pl. 3.
Caretta olivacea Stejneger, Bull. 58, U. S. Mus., 1907, 507.

Localities given for this species are Japan, China, Bonin Islands, Philippines, Bismarck Archipelago, Calcutta, Indian Ocean, Malabar, and East Africa. This is one of the most variable of the marine tortoises. Of five specimens before me two have six costal shields on each side, one has five on one side and six on the other, two have six on one side and seven on the other. Of the same individuals three have two pairs of prefrontals each, and two have each two pairs of prefrontals and an azygous shield in the same area. The specimen having six costal shields on one side and seven on the other agrees in the same respects with that figured by Eschscholtz; none of these individuals agree with it in either shapes or numbers of prefrontals. In the same lot the dorsal shields number from six to eight.

Chelonia japonica.

GREEN TORTOISE.

Testudo japonica Thunberg, Svensk. Vet. Ac. Nya Hand., 1787, vol. 8, 178, pl. 7, fig. 1.
Chelonia japonica Schweigger, Prodr. Mon. Chelon., 1814, 21.

Reported from Japan, Bonin Islands, Formosa, New Guinea, Moluccas, Malay Peninsula, Penang, Bengal, India, and Indian Ocean.

Chelonia depressa.

GREEN TORTOISE.

Chelonia depressa Garman, Bull. Mus. Comp. Zoöl., 1880, vol. 6, 124.

The locality given with the type of this species is North Australia. Whether it was a wanderer there has not yet been determined. Though very distinct from *C. japonica* in the adult stage, it may be much more closely allied to it in the young, in which case indentification of small specimens may present some difficulties.

Eretmochelys squamosa.

HAWK BILL OR SHELL TORTOISE.

Eretmochelys squamata Agassiz, Contr., 1857, vol. 1, 382 (not *T. squamata* Gmelin).
Caretta squamosa Girard, U. S. Expl. Exp. Herp., 1858, 442, pl. 30, figs. 1–7.

Except to the westward and the north the distribution of this tortoise is but partially indicated by the following localities: Japan, Formosa, China, Singapore, Sulu Seas, Moluccas, Bengal, Indian Ocean, Zanzibar, Mauritius, Sunda Islands, Torres Straits, Bismarck Archipelago, Southern Pacific Ocean, Society Islands, Isle de Carmen, Gulf of California. Eight specimens show no variations in costals and frontals. In eight specimens of *E. imbricata*, from the Atlantic, there are three which vary from the normal, of four costals each side and two pairs of prefrontals; one of the three has five costals each side, and two pairs and an azygous prefrontal; another has four costals one side and five the other; and the third has five prefrontals, that is, two pairs and an azygous shield.

OPHIDIA.

HYDRIDAE.

Hydrus platurus.

Anguis platura Linné, Syst., 1766, Ed. 12, 371.
Hydrus platurus Boulenger, Nat. Fauna Ind. Rept., 1890, 397.

Scales on the body hexagonal, juxtaposed, irregular and imbricated on the tail. Longitudinal rows fifty-six; transverse rows three hundred eighty-three on the body, plus fifty-three on the tail. Labials eight on one side, nine on the other; infralabials eleven on each side. A diamond-shaped interparietal, not in contact with the frontal. About sixteen rows of scales on the back are black; below the black a yellow band, from around the snout on the supralabials, passes along each flank, occupying about six rows of scales; below the yellow bands, starting from the chin on the infralabials and along the flanks on each side a band of black, four to six scales in width, continues for about two-thirds of the length beyond which the bands are broken into large rounded spots, five or six, which extend downward into the series on the lower edge of the tail. Between the large spots on the upper edge of the tail and those on the lower edge there are irregular smaller spots of black. The belly to within a short distance from the vent is dingy yellowish; on the gular region there are several spots of brown. The peculiar coloration of this specimen represents an extreme phase of a variation from which, in collections made in Panama and San Miguel, Colombia, for the John E. Thayer Expeditions, we have the intermediates grading into the common black-backed, yellow to brownish-yellow-bellied, spotted-tailed form, without lateral bands of black or brown, common throughout Polynesia. This sea serpent was taken in Lat. 26° 34′ S.; Long. 108° 57′ W., about fifty miles northeast of Easter Island. It has been directly compared with numerous specimens, from China, Gulf of Siam, Singapore, Borneo, Java, Bay of Bengal, Society Islands, and Panama, without discovery of characters on which to base so much as a variety.

SAURIA.

GECCONIDAE.

Lepidodactylus lugubris.

Figs. 1–6.

Platydactylus lugubris D. & B., Erp. Gén., 1836, vol. 3, 304.
Lepidodactylus lugubris Fitzinger, Syst. Rept., 1843, 98.

The Easter Island specimens of this little Gecko are ashy to light brownish-gray. Whether intense or faint, the markings are distinct on all. The brown band from the rostral plate through the eye to the shoulder is bordered above by a white streak that is more distinct on the head behind the eye. Each of these specimens has an elongate small spot of brown or black on the occiput. In most cases there are small elongate spots of brown immediately above the limy bunch at each side of the neck and above the shoulder. The usual pattern on the back from behind the head to the thighs is made up of seven to eight transverse zigzag streaks of brownish, each edged behind by a white one. These lines make a sharp angle forward where they cross the vertebral line. Toward the hips the border becomes darker or black, showing a series of black spots at each side of the median line at the base of the tail, and the white bands become wider and more distinct. In some examples the white band through the eye is more or less faintly indicated along the entire flank, and is bordered above and below with darker lines that start respectively from the top of the eye and from the ear. From a point below the eye, above the angle of the mouth, a narrow light-edged streak of brownish extends backward toward the throat. The head is light brown, mottled with darker; the labials, chin, and throat are whitish, freckled with light brown. The tail has about ten transverse bars of white separated by light brown bands, in each of which, at each side of the median line, a spot of black is common. Posteriorly on the tail the spots of black become less dark and more fused. The lower surface of the tail is white. In several individuals there is an indefinite band of brownish from eye to eye across the forehead; in some one or two less definite bands cross the snout. On Easter Island specimens the bunches, as we may call the limy swellings at each side of the neck, are large and apparently made of two portions, a small posterior and a larger anterior, which latter on some of the larger examples extends somewhat below the throat. In the young these bunches are not to be seen. Specimens from Samoa, collected by Dr. W. McM. Woodworth, differ from the preceding in lacking the spot on the occiput and in having the bunch at each side of the neck smaller, rounder, nearer the shoulder, and farther from the ear. Others from the Fijis show the neck bunches still further reduced in size, so much so as to make them hardly perceptible. One from Mangareva is much darker than the Easter Island representatives; it has fewer transverse bands on the body, but has the occipital spot and those above the bunches; the latter are small and placed far back; on the snout there is a mark shaped like a horseshoe, open forward; a band from eye to eye curves forward, and behind it there is another curving backward. Our specimens from Oahu confirm the remarks made by Dr. Stejneger as to being more robust; they indicate existence of a probable variety (*roseus*). Those from the Marshall Islands are like them. Individuals from Oahu have very large bunches on the neck, extending from shoulder to ear, and towards the nape and middle of the throat; they have numerous and large black spots on the middle of the back (old specimens, probably). Such specimens were described by Cope, 1868, under the name *Peropus roseus;* at most they represent only a variety of *Lepidodactylus lugubris* D. & B., 1836. *Gehyra oceanica,* hitherto not credited to the Hawaiian fauna, was also secured on Oahu. Maui specimens of *L. lugubris* are less robust, are smaller, and the bunches are like those of Easter Island, small and far back. On one of them the bunches are hardly noticeable. The spots are absent from the middle of the back, but are distinct above the shoulders and hips. On an Ebon, Marshall Islands, specimen the bunches are in longitudinally connected groups of three; on others from Apaiang, Gilbert Islands, the bunch is near the shoulder and far from the ear.

The figure of the type furnished by the "Voyage au Pole Sud," Plate 1, Fig. 1, does not present a very correct idea of the markings, as but few are indicated. Those shown are situated as in the greater number of individuals, yet on those which show the spots so distinctly there is, on most examples, a larger number of markings that are quite as characteristic which are not traced in the figure. The drawing shows the two black spots on the neck, a couple of the spots on the base of the tail, a small spot on the occiput, and a number of dark spots irregularly scattered over the body; it has none of the six or seven transverse bands of brownish edged with light between shoulders and thighs and continued in the ten or more bands across the tail, in each of which there is usually a dark spot at each side of the vertebral line.

The Easter Island form appears to be more closely allied with the Hawaiian than with those obtained from islands more directly to the westward.

SCINCIDAE.

Cryptoblepharus poecilopleurus.

Figs. 7-12.

Ablepharus poecilopleurus Wiegm., N. Act. Caes. Leop., 1835, vol. 17, 202, pl. 18, fig. 1.

Cryptoblepharus poecilopleurus Wiegm., l. c., 204.

Excepting in the tendency to vary there appears to be little by which we can separate Easter Island representatives of this species from those taken on certain of the Hawaiian Islands. The latter are regarded as typical of the species. Originally the description was drawn from an individual secured on the islands near Pisacoma, Peru; it in all probability was, like the one reported by Boulenger from Bahia, Brazil, an accidental or a descendant of one that had been carried far from the home of the species. *C. poecilopleurus* is likely to have sprung from *C. boutonii* and to have originated in or near the Hawaiian Islands. The parent form possessed a smaller number of rows of scales and had but four labials in front of each suborbital; or, in a general way, it had a smaller total number of scales on the individual. *C. nigropunctatus* from the Bonin Islands stands closer to *C. boutonii*; its scale rows number from twenty-four to twenty-six, and it has but four labials. A large specimen of this form measures about five and three-fourths inches in total length, the body two and one-eighth; the lateral streaks are very indistinct and the entire upper surfaces are freckled with brown and with silvery white. A couple of specimens from Wake Island must also be placed among those nearer *C. boutonii.* Their differences from one another are of enough interest for description here: — one of them has twenty-eight rows of smooth scales and has no supranasals between the internasal and the nasals; the other has twenty-six rows of faintly grooved scales, has a supranasal on each side, formed by a longitudinal division of the nasal, and has the tail forked near the end in such a manner as to make it appear that the deformity was congenital; each of them has four labials. From these localities southward the number of scale rows decreases. It is to the southwest that the species with fewer rows of scales predominate, the numbers decreasing until on *C. rutilus* there are but twenty. More distant allies from West Australia have sixteen rows and three labials. *C. eximius* from Moala and Naikobu, of the Fijis, has twenty-two rows of scales and four labials. *C. heterurus* from Gilbert Islands exhibits a variational tendency similar to that of *C. poecilopleurus* from Easter Island, but it has a smaller number of rows of scales. Comparing nine specimens from the latter locality with the same number from the Hawaiian Islands, it will be seen that a slight divergence has set in which continued, with isolation, selection unnecessary, for a sufficient period will account for a new variety and eventually a new species, an offshoot from *C. poecilopleurus.* Eight of the nine from Easter Island have 28 rows of scales each, one has 30; two have 4 labials on each side, five have 5 on each side, and two have 4 on one side and 5 on the other; six have normal prefrontals, that is, the prefrontals are in contact between frontal and internasal, two have an azygous prefrontal with the regular prefrontals in contact, and two have the azygous separating the prefrontals. Of nine Hawaiian individuals seven have 28 rows of scales each, two have 30; five have 4 labials on each side, two have 4 on one side and 5 on the other, one has 3 on one side and 4 on the other, and one has 3 on each side; eight have normal prefrontals and one has an azygous shield separating the prefrontals. The Easter Island specimens show an increase in the number of scales on the head; those from the Hawaiian Islands a slight decrease. In the labials alone the four on each side in front of the suborbital, as seen in the greater number of the Cryptoblephari, are represented by an average of four and two-thirds in the Easter Island specimens noted above, and on the Hawaiians by an average of little more than three and nine-tenths. If such averages may not be accepted as differences sufficiently tangible for the establishment of the variety, *paschalis*, they may at least be said to indicate the process of forming new species by means of hereditary tendencies in variation. There is nothing to separate the two localities in the coloration; the redness of the end of the tail is apparent on some. Among the specimens collected by Dr. H. B. Bigelow are some very dark ones, slaty on the belly, on which the light lines are almost invisible; these are marked "taken under rocks," a locality which probably accounts for the difference in color, the species undergoing considerable changes on removal from light to darkness or the reverse. There is nothing in the structure to distinguish the dark ones from the light ones as represented in Fig. 7.

EXPLANATION OF PLATE.

Fig. 1. *Lepidodactylus lugubris* D. and B. Easter Island. One and one-half times natural length.

Fig. 2. Lower view of chin scales.

Fig. 3. A young specimen. Mangareva Island. About one and one-half times natural length.

Fig. 4. Side view of head.

Fig. 5. Lower view of foot.

Fig. 6. Specimen showing a new tail growing from the top of the base instead of, as usually, from the broken end. Suva, Viti Levun Island.

Fig. 7. *Cryptoblepharus poecilopleurus* Wiegm. Easter Island. Enlarged one-ninth of the length.

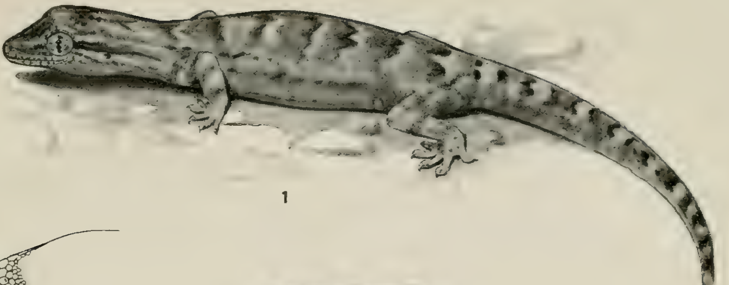
Fig. 8. Upper surface of snout.

Fig. 9. Upper surface of head of a second individual.

Fig. 10. Upper surface of head of a third specimen.

Fig. 11. Side view of head.

Fig. 12. Upper surface of the head of a fourth example showing, with figures 8–10, the variations in squamation.



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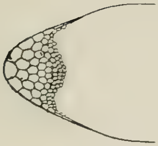

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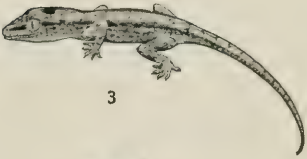

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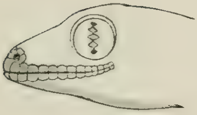

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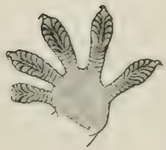

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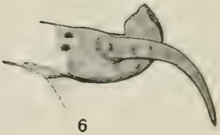

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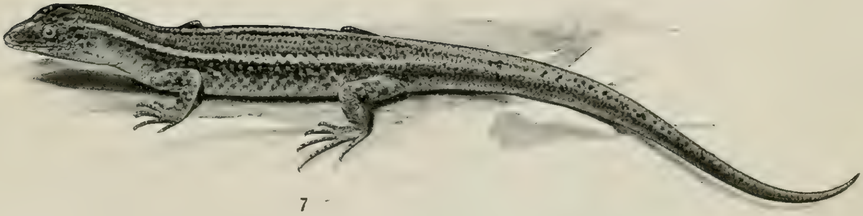

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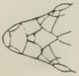

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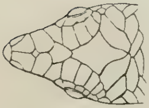

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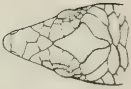

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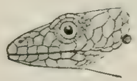

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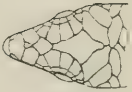

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LII. No. 2.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XIII.

THE CHARACTERS OF ATELAXIA, A NEW SUBORDER OF FISHES.

By Edwin Chapin Starks.

With Five Plates.

[Published by Permission of George M. Bowers, U. S. Fish Commissioner.]

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July, 1908.

No. 2. — *Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of* ALEXANDER AGASSIZ, *by the U. S. Fish Commission Steamer "Albatross," from October*, 1904, *to March*, 1905, *Lieutenant Commander* L. M. GARRET, *U. S. N., Commanding.*

XIII.

The Characters of Atelaxia, a new sub-order of Fishes.

By EDWIN CHAPIN STARKS.

The specimen of *Stylephorus chordatus* upon which this paper is based was obtained by the Agassiz Expedition to the Eastern Tropical Pacific in 1904–1905, at station 4715, which is just south of the Galapagos Islands. The specimen was taken somewhere between a depth of three hundred fathoms and the surface, and was referred to me by Mr. Agassiz through Dr. Evermann for study of its osteological characters.

This is the second specimen known. Before the above date the species was known only from a specimen (now in the collections of the British Museum) taken about the year 1790 in the western Atlantic between the islands of Cuba and Martinique.

The distinctive characters of the Stylephoridae are unique, and of such value that they may be used to define a suborder characterized as follows : —

Atelaxia.

Vertebrae consisting of centra only and without neural or haemal spines or other processes; the opposing halves of the hyoid unconnected and remote from each other; the branchiostegal rays at the upper edge of the ceratohyal and inclined upward; the palato-quadrate bar atrophied; the lower pharyngeals concealed by skin and much reduced; the ethmoid far anterior to the vomer and supported by a projection from the parasphenoid; no obitosphenoid present; the caudal divided and part of the rays turned upward, the lower three enlarged and produced backward into a long process.

Minor characters of the Atelaxia may be included in the following definition of the family.

Stylephoridae.

Form elongate and compressed; the skeleton but little ossified; dorsal extending from head nearly to caudal fin, its rays without cross articulations; base of pectoral horizontal and the fin inclined upward; no anal or ventral fins; mandible enormously developed but with little movement; mouth small, tube-like, the maxillaries largely instrumental in its opening and closing; both maxillary and premaxillary with long processes extending over the top of cranium; myodome developed but without basisphenoid in connection; four pairs of superior pharyngeals present, all but the first pair bearing teeth; a greatly enlarged, pen-shaped, basibranchial present, almost as long as the cranium; post-clavicle of a single piece and extending far backward; posttemporal a simple unforked bone; a short slit behind fourth gill arch.

Relationship.

Stylephorus appears to be one of the many aberrant forms whose relationship must remain uncertain, as the intermediate forms through which it could be traced to the parent stock, have disappeared.

The Stylephoridae has been placed by most authors with the Trachypteridae and Regalecidae under the suborder Taeniosomi. Though it is at the most only distantly related to these families it is still more closely related to them than to other known forms.

Its affinity to the Taeniosomi is shown by the poorly ossified skeleton; the horizontal pectoral base; the upturned caudal fin; the absence of cross articulations in the dorsal rays; the reduction of the lower pharyngeals;[1] the presence of four pairs of superior pharyngeals; and the ascending processes to the maxillaries as well as to the premaxillaries.

For comparison the characters of the Taeniosomi are here included.

Taeniosomi.[2]

Vertebrae, hyoid arch, position of branchiostegal rays, palatoquadrate arch, position of ethmoid in relation to vomer, and mouth parts normal; the epiotics in contact with each other behind the supraoccipital widely separating the latter from the occipital region and the foramen magnum; the parietals enlarged and anterior in position; an orbito sphenoid present;[3] the post-temporal unforked and suturally joined to the cranium overlying the outer half of the epiotic and extending forward to the parietal; the lower pharyngeals rod-like and parallel with the branchial arches (or absent?); the dorsal composed of soft inarticulate spines; a pelvic girdle present.

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[1] Dr. Gunther reports (Cat. Mus. Brit. Mus., 1861, vol. 3, p. 306) the lower pharyngeals of *Trachypterus arcticus* to be wholly wanting.

[2] The characters and relationships of the Taeniosomi have been discussed by Dr. Gill in the Amer. Nat. 1887, vol. 21, p. 86, and 1890, vol. 24, p. 481.

[3] The presence of an orbito sphenoid would be evidence towards a Physostomus origin for the two suborders here considered.

In the above comparisons I have used the beautifully illustrated and detailed report of T. Jeffery Parker on the skeleton of *Regalecus argenteus*[1] (Trans. Zool. Soc., 1886, vol. 12, p. 5–34, pl. 2–6).

The Osteology of Stylephorus.

The posterior part of the cranium is normal in position and number of the elements, except that the opisthotic and basisphenoid are absent.[2]

The pterotic is a rounded bone, normal in position and size, but without a process. The epiotic process is reduced to a mere tubercle of bone to which the upper shoulder girdle element is attached.

The alisphenoids are well separated from each other by the wide anterior opening to the brain case.

The myodome is well developed, but broad and short and not opening to the exterior at the posterior end of the parasphenoid.

Each exoccipital shares equally with the basioccipital the support of the vertebral column.

The ethmoid is a thin vertical plate but little ossified projecting forward from the frontals. Along the posterior edge of the ethmoid the poorly ossified prefrontals stand outward at an angle on each side.

The vomer is a very small bone situated behind the ethmoid and prefrontals on a slightly downward projecting portion of the parasphenoid. In the majority of bony fishes the vomer is anterior to the ethmoid and the prefrontals, and is suturally connected to them at its upper posterior edges.

From the upper surface of the lateral wings of the parasphenoid, just behind the vomer a long slender process springs and runs forward far beyond the vomer. It is thin in the middle and somewhat thickened and rod-like at each edge. To the upper surface of this the thin ethmoidal plate is attached, and the rod-like edges pass under the lower ends of the prefrontals, though the attachment to the prefrontals is not close. The relationship of the rod-like portions of this process to the prefrontals suggests that they be the palatines, though the attachment of the ethmoid to the upper surface of the process is against this supposition, unless the median portion of it is an extension of the parasphenoid. I know of no other instance where the parasphenoid extends anterior to the vomer. When the palatines have lost their connection with the pterygoid it seems possible that they may have swung inwards at their inner ends and become attached to the parasphenoid. This theory is suggested only as a possibility. It seems more reasonable to suppose that the palatines have failed to ossify, and that the above process is of the parasphenoid.

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[1] Mr. Parker's paper illustrates the value of descriptions and drawings in detail of every skeleton reported upon even when a detailed description may be irrelevant to the problem in hand.

Descriptions and illustrations of skeletons of rare forms are valuable though the author may have no problem in connection with them.

[2] The importance of these elements is apparently not great; the presence of the former depending in some degree upon a lower limb to the posttemporal, or at least a well developed ligament representing a lower limb. The absence or presence of an opisthotic or basisphenoid seems to be little more than generic in value.

The lateral head bones are bent forward and downward against the large mandible, and all of them are anterior to the posterior end of the mandible. The mesopterygoid and metapterygoid are absent.

The usual opercular bones are present, but so bent forward that the preopercle is inferior to the others instead of in front of them as is usual. The ligament connecting the interopercle with the angular has ossified for the greater part of its length.

The hyomandibular and quadrate are elongate bones, but normal in their relation to each other and the other bones. The former has a simple rounded head for articulation with the cranium, no mesopterygoid process, but with the usual processes for the opercle and preopercle, though these are only slightly developed. The symplectic is slender and not much ossified; it extends downward behind the quadrate. The pterygoid is a very small sliver of bone closely attached against the anterior edge of the quadrate.

The three usual bones make up the enormously developed mandible. The dentary is abruptly narrowed at its anterior end to form the small mouth.

The premaxillary is a broad fan-shaped bone with a long process extending back at the side of the ethmoid to the top of the head. The maxillary has a similar process extending upward behind and parallel with the premaxillary process. The opening of the mouth apparently depends to a large degree upon the maxillary elements, as the mandible is connected by skin rather closely to the side of the head.

The condition existing in the hyoid apparatus is unique. Each side of the hyoid arch lies wholly in front of the branchial arches, its lower edge on a level with the greatly enlarged first basibranchial (glossohyal). It is unattached and widely separated in front from its opposite fellow. As the branchiostegal rays are on the upper edge of the cerato hyal and inclined upward rather than on the lower edge and inclined downward, as is usual in other Teleosts, the movement of the hyoid must be outward from the upper edge instead of from the lower, thus enabling the fish to spread the lateral bones of the head wide apart somewhat as is shown in the picture published by Shaw (Trans. Linn. Soc. Lond., 1791, vol. 1, pl. 6) and copied by Goode and Bean (Oceanic Ichthyology. Mem. Mus. Comp. Zoöl., 1896, vol. 22, pl. 116, fig. 394). The interhyal is a very long fan-shaped bone with its upper end uneven and fibrous and loosely attached so that this outward movement is not retarded.

The first two branchial arches are attached to one large basibranchial. Anterior to this is a very long pen-shaped bone, nearly as long as the cranium. It is probably the homologue of the glossohyal, though it is unattached to the hyoid arch. The hypobranchial of the first arch only is present. All of the superior pharyngeals are present; a styloid toothless pair on the first arches, and three tooth-bearing pairs behind them. The lower pharyngeals are nearly obsolete, toothless, and covered with skin, and bordering the short slit between them and the fourth arch.

The clavicle is an S-shaped bone bending forward toward the cranium above and backward around the hypocoracoid below. The supraclavicle is joined to the lower and inner surface of the upper limb rather than to the outer surface. It is a long, slender, fibrous bone reaching far forward. To it in turn is joined the simple posttemporal, which resembles the supraclavicle in shape and texture, though it is shorter. The posttemporal joins the small epiotic process rather loosely, and has no other attachment to the cranium. A long slender ray of bone attached to the upper inner edge of the clavicle and extending backward represents the postclavicle.

The other elements of the shoulder girdle are poorly ossified. Two delicate thin plates, more cartilage than bone, represent the hypercoracoid and hypocoracoid. The latter arches away from the clavicle and rejoins it at its lower end in the typical way; the former bears a small foramen near its border next to the clavicle. Four actinosts are present in a horizontal row; the suture between the coracoid elements is opposite the third one. They are delicate broad plates as poorly ossified as the coracoid elements.

The caudal portion of the vertebral column is in no way differentiated from the thoracic; the vertebrae number fifty-three. Each vertebra consists of a centrum, somewhat smaller at the middle, and having a pair of thin longitudinal ridges above and below representing open neural and haemal canals, but there are otherwise no spines or processes of any sort, and no ribs are present. The last vertebra expands posteriorly into a narrow hypural plate from the lower half of which the long filamentous process projects backward, and from the upper edge the small caudal rays project upward. The long caudal process is formed from the lower three caudal rays, which are very much stronger than the upper rays.

The interneural rays are cartilaginous with soft fibres of bone intermingled. They are T-shaped with the posterior part of the cross limbs much longer than the anterior, and all connected so that a continuous band of fibrous bone is formed along the back. A short distance in front of the shaft of each interneural at the union of the cross limbs is situated the dorsal ray. The band formed by the cross limbs is of the sort shown by Parker (l. c.) in his picture of Regalecus, though it is straight not V-shaped between the dorsal rays. The shaft of each interneural is long and slender, and runs from the back to the vertebral column, where it is in contact with the upper surface of the vertebra; two of them to each vertebra. There are no interhaemals or other evidence of an anal fin. The dorsal rays show no trace of cross articulations.

The viscera was so disintegrated that little could be made out. The intestine is long and straight, and without pyloric caeca. An air bladder was apparently present, not as a loose sack, but as a membranous septum dividing the upper part of the abdominal cavity from the lower. No air duct could be made out from this to the œsophagus.

EXPLANATION OF PLATES.

Abbreviations.

a	actinosts.
als	alisphenoid.
ang	angular.
art	articular.
bbr	basibranchial.
boc	basioccipital.
brs	branchiostegal rays.
c.	clavicle.
cbr	ceratobranchial.
chy	ceratohyal.
den	dentary.
dsp	dorsal rays.
ephy	epihyal.
epo	epiotic.
eth	ethmoid.
exo	exoccipital.
fr	frontal.
ghy	glossohyal.
hbr	hypobranchial.
hco	hypercoracoid.
hhy	hypohyal.
hy	hyomandibular.
hyco	hypocoracoid.
ihy	interhyal.
in	interneural.
iop	interopercle.
max	maxillary.
ol	ossified ligament.
op	opercle.
par	parietal.
pc	postclavicle.
pf	prefrontal.
pmax	premaxillary.
pop	preopercle.
pot	posttemporal.
ppr	parasphenoid process.
pro	prootic.
prs	parasphenoid.
pt	pterotic.
pter	pterygoid.
sc	supraclavicle.
coc	supraoccipital.
sop	subopercle.
sph	sphenotic.
sy	symplectic.
v	vomer.
vert	vertebra.

PLATE 1.

Stylephorus chordatus Shaw.

Station 4715. Lat. 2° 40.4′ S. Long. 90° 19.3′ W. 300 fathoms.

Starks. — Atelaxia. Plate 1.

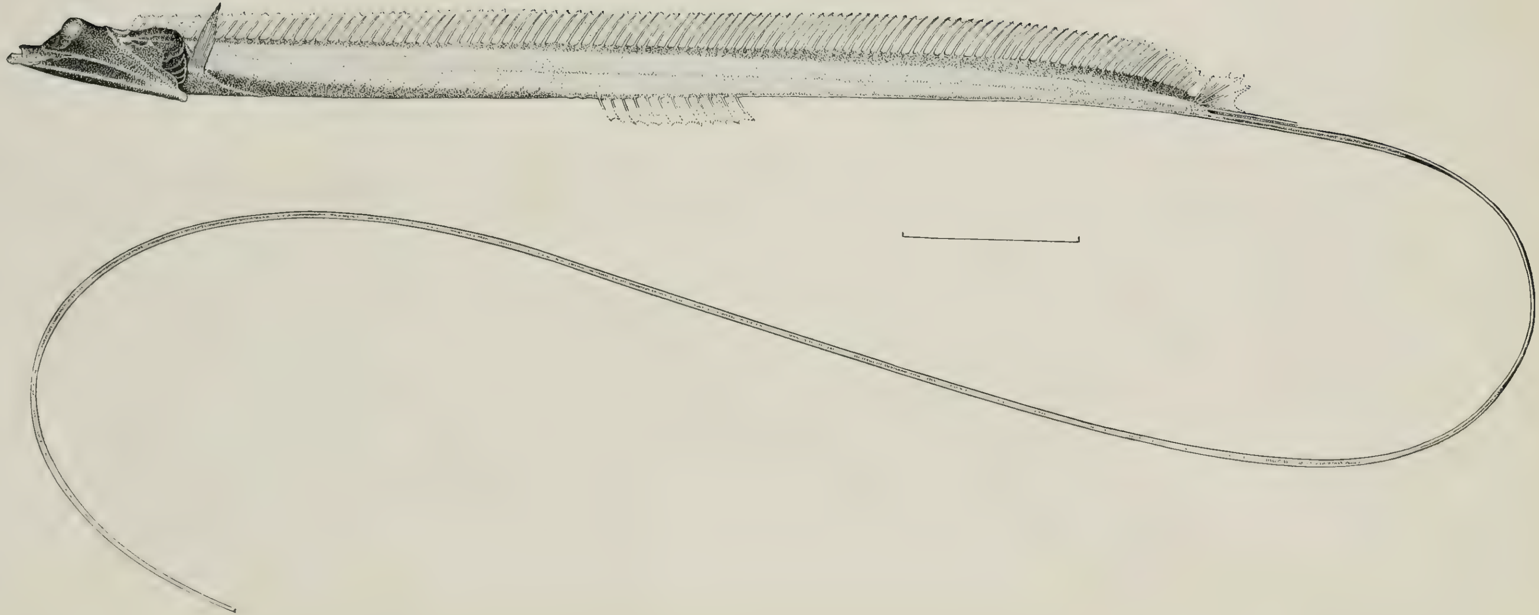
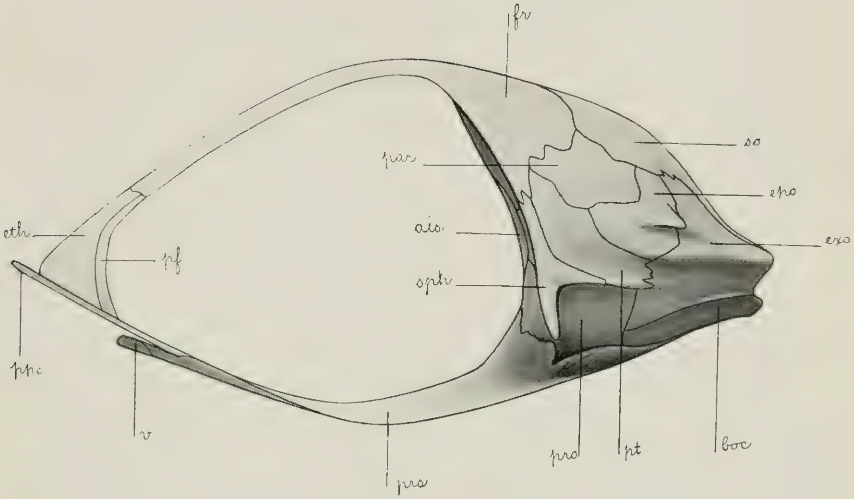


PLATE 2.

Stylephorus chordatus Shaw.

Fig. A. Lateral view of cranium.
Fig. B. Superior view of cranium.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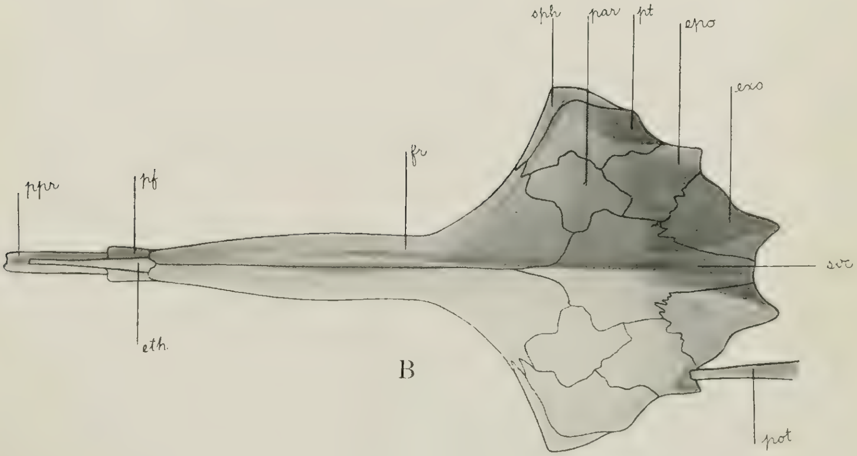
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PLATE 3.

Stylephorus chordatus Shaw.

Lateral bones of head.

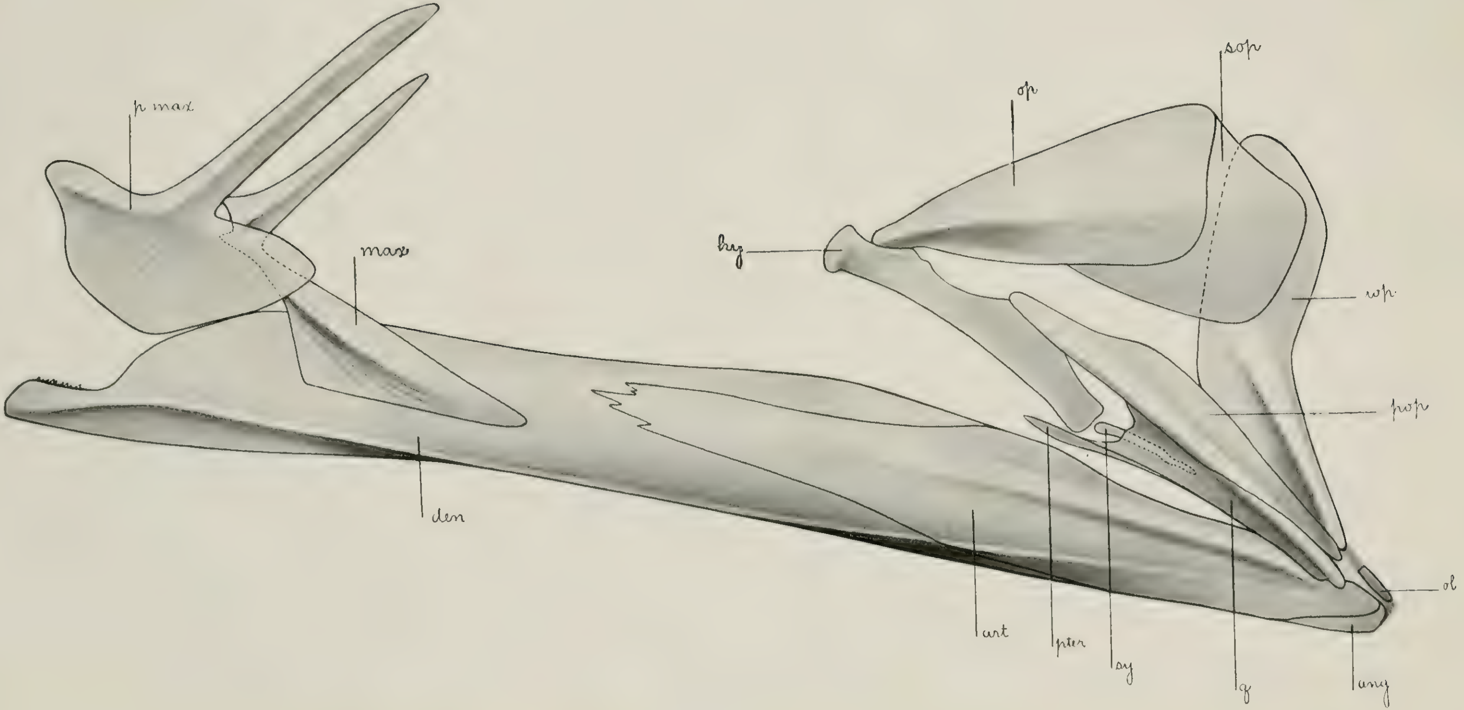
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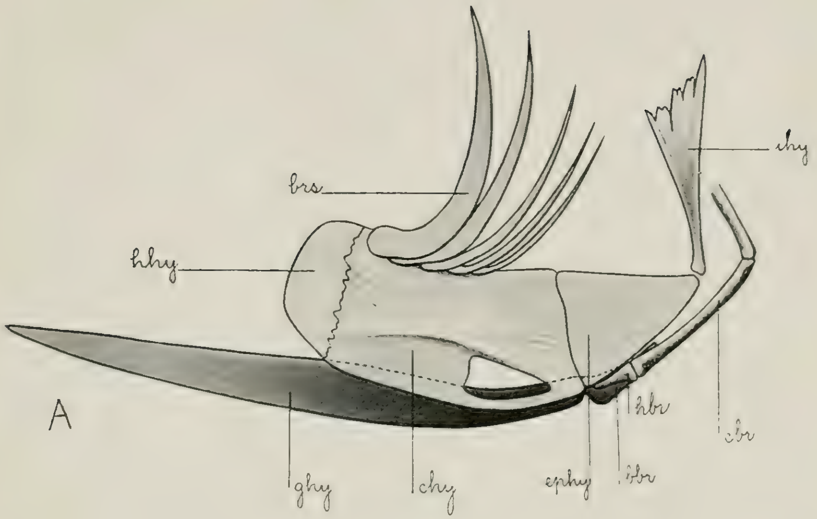
PLATE 4.

Stylephorus chordatus Shaw.

Fig. A. Hyoid and base of branchial arches. Lateral view.

Fig. B. Hyoid and base of branchial arches. Superior view, showing hyoid bones turned outward horizontally with inner surface exposed.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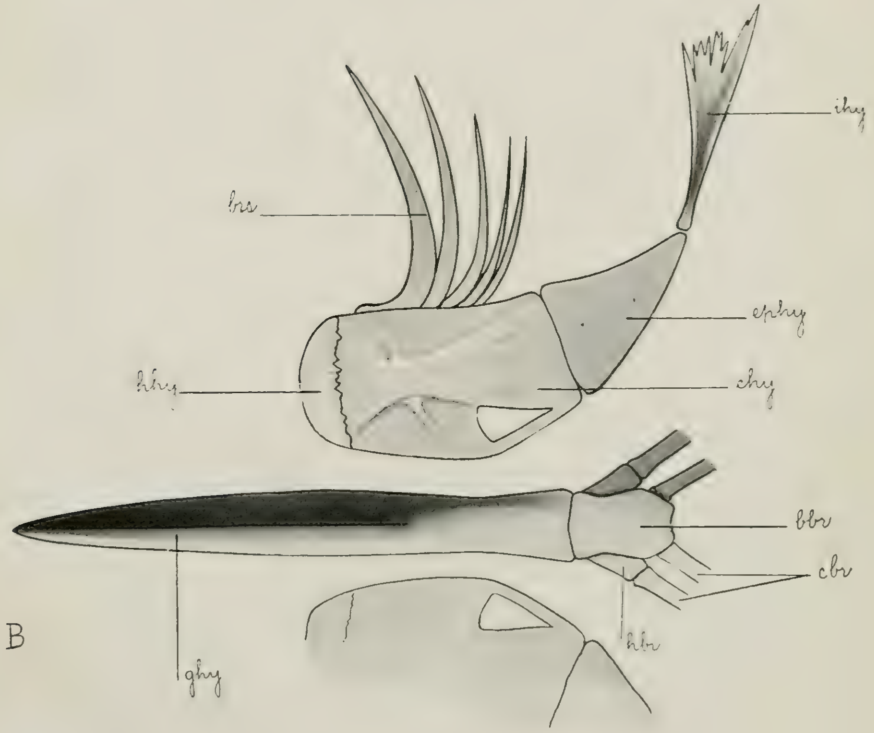
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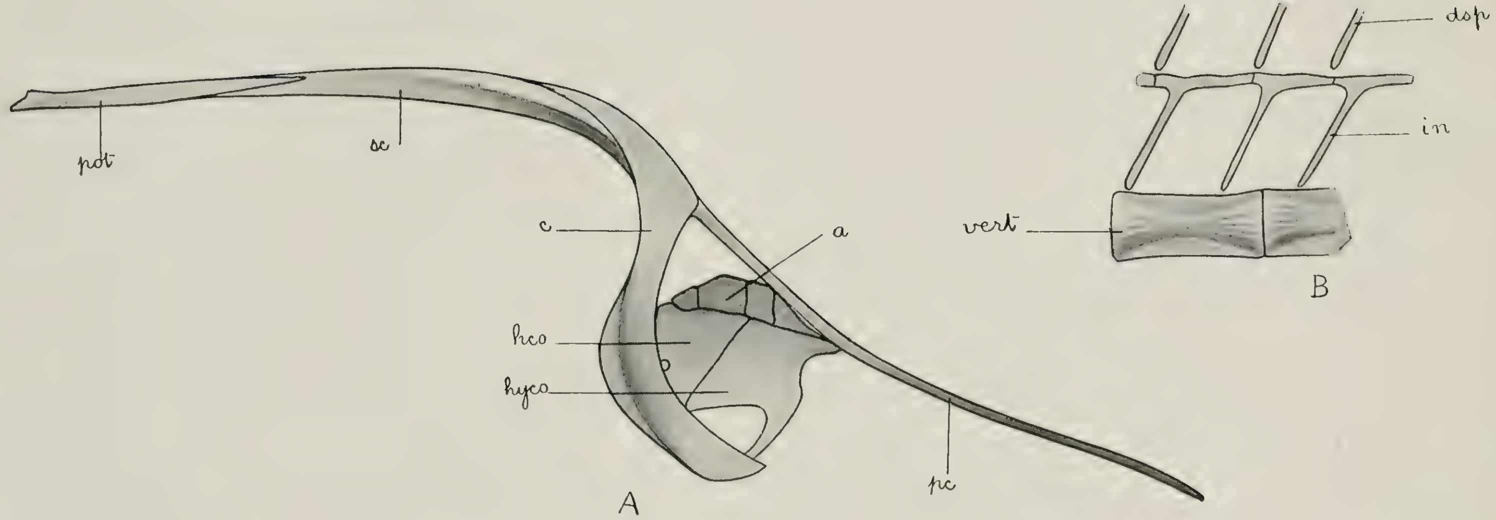
PLATE 5.

Stylephorus chordatus Shaw.

Fig. A. Shoulder girdle. Outer surface.

Fig. B. Section of vertebral column from near the middle of the body, showing interspinous rays and base of dorsal spines.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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LII. No. 3.

NOTES ON CHIROPTERA.

BY GLOVER M. ALLEN.

WITH ONE PLATE.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
JULY, 1908.

No. 3. — *Notes on Chiroptera.* By GLOVER M. ALLEN.

THE collection of bats in the Museum of Comparative Zoölogy contains upwards of 190 species, represented by skins, skeletal parts, and alcoholic specimens. Many of these specimens are of unusual interest. I have made the following notes while studying this material recently. In the case of certain imperfectly known species detailed series of measurements or other data of interest are given, and five species are described as new.

Of especial note are the collections received from the Thayer Expedition to Brazil, made in 1865, under the direction of Louis Agassiz; also a considerable number of Indian bats sent at about the same time by Rev. M. M. Carleton from northern India and the Koolloo Valley. More recently a valuable series of alcoholic specimens from Java and Japan was presented by Mr. Thomas Barbour, in part collected by himself in 1906–07. I am indebted to the authorities of the Museum of Comparative Zoölogy for the privilege of making this report, and to the United States National Museum, through Dr. M. W. Lyon, Jr., for the loan of certain specimens.

All measurements are in millimeters, and colors are after Ridgway's Nomenclature of colors. I have followed the nomenclature and order adopted by Miller in his monograph on "The families and genera of bats" (Bull. 57, U. S. Nat. Mus., 1907).

PTEROPIDAE.

Cynopterus brachysoma DOBSON.

The collections of Mr. Thomas Barbour establish for the first time, apparently, the occurrence of two species of Cynopterus in the island of Java. The larger of these is clearly the *Pteropus titthaecheilus* of Temminck, noticed below; the smaller species is represented by five adult females and four immature specimens, all from Buitenzorg. These I have with some hesitation referred to *Cynopterus brachysoma* of Dobson, with the description of which they closely agree, notwithstanding that the type came from Southern Andaman Island. All the specimens show the small lobe at the inner base of the outer margin of the ear, which Dobson believed to be characteristic of his species. The margin of the ear is edged with whitish, though in some specimens this is apparent on the inner margin only. The fingers also are whitish on both superior and inferior surfaces. This bat is probably closely related to *C. scherzeri* of the Nicobar Islands, but is clearly smaller and with a different skull. It approaches nearest to *C. montanoi*, but differs in numerous minor details if one may judge by the description. Should it eventually prove that the Javan animal is distinct from *C. brachysoma* of the Andaman Islands, it is probable that Gray's name, *horsfieldi*, would be available for it, although his description applies almost as well to *C. titthaecheilus*, save in the forearm length, which is given as "2½ inches?" (= 64 mm.). The following are the measurements of four adult females from Buitenzorg, Java, and for comparison, Dobson's measurements (converted into millimeters) of the type of *C. brachysoma* from Southern Andaman Island are added.

MEASUREMENTS OF CYNOPTERUS BRACHYSOMA.

No.	Head and Body.	Tail.	Ear.	Fore-arm.	Second Digit.	Third Digit.	Fifth Digit.	Tibia.	Foot.
Dobson	74.0	6.4	15.0	55.5	—	101.5	76.0	20.3	13.0
6943	78.7	9.5	16.0	61.0	42.0	98.0	77.0	20.0	14.0
6945	83.0	8.7	17.0	62.0	43.5	103.8	78.3	21.0	14.5
6946	74.0	8.7	15.0	63.0	43.0	105.5	81.0	21.4	14.5
6947	81.5	7.3	16.5	61.5	40.0	97.0	78.5	21.3	12.0

It will be seen that Dobson's specimen had a slightly shorter forearm than the Javan ones, but the other dimensions seem to be about the same.

The following cranial measurements are taken from the skull of No. 6946: greatest length, 29.3; basal length, 26; interorbital constriction, 6.2; zygomatic breadth, 19; mastoid breadth, 12; mandible, 22; maxillary tooth row (exclusive of incisors), 10; mandibular tooth row (exclusive of incisors), 11.

Cynopterus titthaecheilus (Temminck).

Four adults of both sexes, and one immature female, were taken at Buitenzorg, Java, by Mr. Thomas Barbour. As shown by Miller (Proc. U. S. Nat. Mus., 1903, vol. 26, p. 474) this is doubtless the type locality, as Temminck gives the habitat of this species as "les îles de Java et de Sumatra" and mentions "une grande quantité de sujets capturés à Buitenzorg." Mr. Miller's series of bats from Sumatra is stated to show no indication of a whitish border to the ears, but this character is plainly present in the alcoholic specimens obtained by Mr. Barbour in Java, and is mentioned also by Temminck. A Javanese specimen skinned out from alcohol agrees well in color with that described by the latter.

MEASUREMENTS OF CYNOPTERUS TITTHAECHEILUS.

No.	Total Length.	Tail.	Ear.	Fore-arm.	Thumb.	Second Digit.	Third Digit.	Fifth Digit.	Tibia.	Foot.
6934	115.0	11.5	20	78.5	33	53.5	128	100	31.0	19.0
6935	117.5	10.0	21	78.5	33	53.0	130	97	34.0	18.6
6936	118.0	9.0	21	79.0	33	53.0	130	102	31.3	18.0

In his original description, Temminck gives the following measurements (here converted into millimeters): total length, 127; forearm, 76; distance from anterior corner of eye to tip of nostril, "7 lignes," or about 15.5. The forearm measurement corresponds closely with that of our specimens, which are evidently larger than those from Sumatra referred by Mr. Miller to this species. It seems probable that the Sumatran bat is distinct.

The following cranial measurements are from the skull of an adult male, No. 6937, from Buitenzorg, Java: greatest length, 36; basal length, 32; interorbital constriction, 6.5; zygomatic breadth, 23.8; mastoid breadth, 14; mandible, 28; maxillary tooth row (exclusive of incisors), 12.7; mandibular tooth row (exclusive of incisors), 14.

The collection also contains a mounted specimen labelled "Borneo," whose thumb and (dried) ear are smaller, but otherwise it is practically identical with this species. Its range may eventually be found to be more extensive than at present supposed.

Ptenochirus lucasi (DOBSON).

Two alcoholic specimens from Sarawak, Borneo, agree well with the characters given by Dobson.

Rousettus collaris (ILLIGER).

Two specimens, Nos. 6748, ♀, 6749, ♂, from Cairo, Egypt, seem to be this species rather than *R. aegyptiacus*, and probably indicate nearly the northern limit of its range. They are preserved in alcohol, and measure as follows: tail, 13, 15.5; ear from crown, 18, 18; forearm, 93, 95; thumb, 35, 35; 2d digit, metacarpal, 47, 44.5; 1st phalanx, 9, 10; 2d phalanx, 10, 9.4; 3d digit, metacarpal, 62, 62; 1st phalanx, 41, 42; 2d phalanx, 56.4, 57.7; 4th digit, metacarpal, 61.5, 60; 1st phalanx, 32.3, 31; 2d phalanx, 37.5, 36.5; 5th digit, metacarpal, 60, 59; 1st phalanx, 30, 29; 2d phalanx, 29, 27.5; tibia, 41, 40.6.

Pteropus ariel, sp. nov.

Type. — Adult male (skin and skull), No. 10,565, Museum of Comparative Zoölogy; collected at Male Atoll, Maldive Archipelago, by H. B. Bigelow, A. Agassiz Expedition, December 24, 1901.

General Characters. — Color essentially as in *Pteropus giganteus* (Brünn.), but size smaller; rostrum much blunter and shorter, with a consequent crowding of the cheek teeth.

Color. — Skin of face, muzzle, and chin black, thinly clothed with black and burnt-umber hairs; throat and crown of head burnt umber, passing into ochraceous and ochre yellow on the nape and shoulders; back black, with scattered grayish hairs and posteriorly with a slight admixture of brown hairs (nearly burnt umber). Chest and abdomen ferruginous or orange rufous, becoming blackish about the anal region and on the sides of the body. Membranes and ears black.

Skull and Teeth. — Skull slightly narrower with narrower brain case and more slender zygomata as compared with Indian specimens of *P. giganteus* from the Koolloo Valley. The sagittal crest is as strongly developed and the teeth are as large as in *P. giganteus*, but the rostrum is conspicuously shorter and relatively broader, so that it does not taper as noticeably as in the continental species. In consequence of the shortened rostrum, the tooth row is also shortened and the teeth are more crowded.

Measurements. — External measurements of the type skin (measurements in parentheses are from a skin of *P. giganteus* of approximately the same age, from Koolloo Valley, India): ear, 30 (31.5); forearm, 160 (–); thumb, 63 (73.5); 2d digit, 115 (130); 3d digit, metacarpal, 105 (114); 1st phalanx, 77 (86.5); 2d phalanx, 112 (108.6); 4th digit, metacarpal, 107 (115); 1st phalanx, 64 (69); 2d phalanx, 66 (65 +); 5th digit, metacarpal, 112 (119); 1st phalanx, 45 (52); 2d phalanx, 52 (54); tibia, 74 (–); foot, 41 (47).

Cranial measurements of the type (and in parentheses those of an adult from Koolloo Valley, India): greatest length, 66 (–); basal length, 63 (–); interorbital constriction, 8 (8); zygomatic breadth, 36.7 (40.8); mastoid breadth, 21.4 (22); palatal notch to incisive foramen, 31 (36.4); mandible, 54 (56.5); maxillary tooth row (exclusive of incisors), 25.3 (28.3); mandibular tooth row (exclusive of incisors), 29.3 (31).

Distribution. — So far as known, this species is confined to the Maldive Archipelago.

Remarks. — In addition to the type there is an immature female in the collection, also from Male Atoll. The sutures are still plainly visible in the skull, and a comparison with similar skulls of *P. giganteus* from Koolloo Valley, India, shows that the nasals, in addition to being much shorter, are wider in the middle, and expand less abruptly at the distal end. (See Pl. **1**, Figs. 1–4.)

The peculiar short, broad rostrum, and nasal bones, correlated with the slightly more crowded tooth row, as well as the lesser size of this bat, distinguish it readily from *P. giganteus* of the Indian mainland, which is doubtless its nearest ally.

Pteropus ualanus Peters.

Specimens of this bat seem to be rare in collections, so that it is desirable to include measurements of two males, Nos. 3272, 3273, alcoholic, from Strong's Island, Caroline group: ear, 23.4, 24; forearm, 130, 126; thumb, 57, 57; 2d digit, 92, 93.5; 3d digit, metacarpal, 93, 89.5; 1st phalanx, 65, 63; 2d phalanx, 96, 91.5; 4th digit, metacarpal, 90, 88; 1st phalanx, 53.3, 53; 2d phalanx, 57.5, 55.3; 5th digit, metacarpal, 94, 93; 1st phalanx, 41, 41; 2d phalanx, 42, 39; tibia, 56, 57; foot, 34, 35.

Cranial measurements: greatest length, 62, 61; basal length, 55, 53.6; interorbital constriction, 7, 6.3; zygomatic breadth, 39, 35; mastoid breadth, 22, 21; mandible, 48.5, 48; maxillary tooth row (exclusive of incisors), 22.5, 22; mandibular tooth row (exclusive of incisors), 24.7, 26.

EMBALLONURIDAE.

Emballonura nigrescens (Gray).

Four specimens, collected by Mr. Thomas Barbour in Ternate, Moluccas, measure as follows:

MEASUREMENTS OF EMBALLONURA NIGRESCENS.

No.	Sex.	Total Length.	Tail.	Ear.	Fore-arm.	Third Digit.	Tibia.	Foot.
6795	♂	46.5	13.5	9.5	34.0	54.0	11.0	6.0
6796	♀	53.0	15.0	9.0	35.7	56.0	12.0	5.8
6797	♀	50.0	13.6	9.0	35.4	54.5	11.0	5.7
6798	♂	52.0	15.0	9.3	35.4	54.0	11.6	5.5

Rhynchiscus naso (Wied).

As pointed out by Miller, the Old World genus Emballonura is the most primitive of the family, and the only one possessing two permanent upper incisors on each side. It is therefore interesting to find that in a large embryo of *Rhynchiscus naso*, from Porto Seguro, Brazil, there are 2–2 upper milk incisors, and in a series of nine adults from the same locality, three (Nos. 4212, 4217, 4219) have what appears to be a persistent upper milk incisor on the outer side of each permanent incisor. These persistent teeth are so large as to appear like functional teeth of the permanent dentition and are very similar in size and shape to these latter. The forearm measurement of the nine adults averages about 39.5 mm. (38–41).

Peropteryx canina (Wied).

In a paper on the mammals of Margarita Island, Venezuela (Proc. Biol. Soc. Washington, 1902, vol. 15, p. 95), I referred to "Peropteryx sp.," a single damaged specimen collected there in 1901. The Museum has since received an alcoholic specimen, No. 6952, from the same island, and it seems to agree essentially with specimens taken by Robinson and Lyon (Proc. U. S. Nat. Mus., 1901, vol. 24, p. 159) at La Guaira, on the adjacent mainland. Its measurements are: tail, 13; forearm, 43.5; thumb, 8.5; 3d digit, metacarpal, 39.4; 1st phalanx, 11.6; 2d phalanx, 19; 4th digit, 50.3; 5th digit, 48.6; tibia, 18; foot, 7.6; calcar, 17. As the original description of *P. canina* contains no measurements of diagnostic value, the following dimensions are added, from a male specimen in alcohol taken at Rio das Velhas, Brazil (Wied's specimens were from "Brazil"): tail, 13; forearm, 39; thumb, 8; 2d digit, 34; 3d digit, metacarpal, 36; 1st phalanx, 11.3; 2d phalanx, 19; 4th digit, metacarpal, 30; 1st phalanx, 8; 2d phalanx, 8; 5th digit, metacarpal, 30.2; 1st phalanx, 9.8; 2d phalanx, 6.5; tibia, 18; foot, 7.4; calcar, 14.4. The dimensions of this Brazilian bat closely approximate those of *P. trinitatis* from Trinidad (see Miller, Bull. Amer. Mus. Nat. Hist., 1899, vol. 12, p. 180).

NOCTILIONIDAE.

Noctilio leporinus (Linné).

Four alcoholic specimens, from unknown locality, show an interesting variation in the proportions of the metacarpals. In No. 6769, the second and third metacarpals are of equal length; but in the three other individuals, the second metacarpal is shorter than the third by 1, 2, and 4.7 mm. respectively.

NYCTERIDAE.

Nycteris javanica E. Geoffroy.

A fine series of this species was procured by Mr. Thomas Barbour, from shallow limestone caves near Buitenzorg, Java. Both sexes were found together in the caves, as well as numbers of immature bats whose pelage is uniformly smoky, instead of with the yellowish tint of the adults. An adult female, alcoholic, No. 6810, measures as follows: total length, 120; tail, 64; ear, 26.7; forearm, 49.5; thumb, 17.5; 2d digit, 43; 3d digit, metacarpal, 35.5; 1st phalanx, 24; 2d phalanx, 27.2; 4th digit, metacarpal, 40.3; 1st phalanx, 13.5; 2d phalanx, 12.2; 5th digit, metacarpal, 42; 1st phalanx, 14.5; 2d phalanx, 13; tibia, 23; foot, 11.3; calcar, 20.5. The forearm measurement of eight adults averages about 48.2 mm. (47–49.5).

Nycteris aethiopica luteola Thomas.

This recently described race from British East Africa is "slightly larger" than typical *N. aethiopica;* and as but three external measurements are given by Thomas (Ann. Mag. Nat. Hist., 1901, ser. 7, vol. 8, p. 30), I append the following measurements of an alcoholic male, No. 3859, and female, No. 3860, both from Zanzibar: tail, 56, 56.8; ear, 27, 29; forearm, 49, 50.5; thumb, 14.6, 15.8; 2d digit, 39, 39; 3d digit, metacarpal, 36.5, 39; 1st phalanx, 25, 25; 2d phalanx, 23.8, 26.5; 4th digit, metacarpal, 49, 42; 1st phalanx, 15, 14.3; 2d phalanx, 11.3, 11.5; 5th digit, metacarpal, 41.3, 44; 1st phalanx, 13, 13.5; 2d phalanx, 12, 13; tibia, 22, 22.6; foot, 11, 11.5; calcar, 19, 18.7. Another Zanzibar specimen is mentioned by Thomas as the one referred by Dobson (Proc. Zool. Soc. London, 1879, p. 718) to *N. aethiopica.*

MEGADERMIDAE.

Megaderma trifolium E. Geoffroy.

Two adult males and two adult females were collected by Mr. Thomas Barbour at Tjibodas, Java, in a deep cave called Tjibureum. This cave is at an altitude of about 4000 feet on the slopes of the volcano Pangarango, and it is here that the specimens of Megaderma from this portion of Java are taken, as the species seems to be local in its distribution. The Museum has also a fifth Javan specimen presented by Mr. Alexander Agassiz some years ago. As the differences in size are very slight, that Andersen and Wroughton (Ann. Mag. Nat. Hist., 1907, ser. 8, vol. 19, p. 120) have pointed out as characteristic of the Javan animal, it is of value to give the dimensions of those in the Museum collection.

MEASUREMENTS OF MEGADERMA TRIFOLIUM.

No.	Head and Body.	Ear.	Fore-arm.	Second Digit.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Nose leaf.	Sex.
5980	64.5	37.0	54.5	47.4	96.0	75.0	30.5	16.0	12.0	♂
6791	66.0	33.5	55.7	48.0	100.0	78.5	28.3	16.0	12.0	♂
6792	65.8	36.4	57.0	51.5	101.0	80.0	30.0	16.3	13.0	♂
6793	64.5	35.0	57.0	50.0	104.4	82.3	29.0	16.7	12.4	♀
6794	70.0	34.0	58.6	52.0	105.5	82.0	28.3	17.0	12.0	♀

Lavia frons (E. Geoffroy).

Two specimens of this genus from Zanzibar seem referable to *L. frons* rather than *L. rex.* Both are males, in alcohol, Nos. 1138, 1139. In the former the secondary lobe of each tragus has three distinct serrations distally, while in the latter these lobes are practically entire, though with a slight indication of a tooth near the tip. This character is thus probably an individual variation as suggested by Miller (Proc. Biol. Soc. Washington, 1905, vol. 18, p. 228).

RHINOLOPHIDAE.

Rhinolophus ferrum-equinum regulus Andersen.

Four skins with skulls, collected by the Rev. M. M. Carleton, in the Koolloo Valley, India, correspond more nearly with this race than with the neighboring allied races *tragatus* or *proximus*.

Rhinolophus acuminatus Peters.

An adult female, No. 6868, in alcohol, was collected by Mr. Thomas Barbour at Buitenzorg, Java, and presents the following measurements: total length, 81; tail, 26.5; ear, 18.7; forearm, 48.4; thumb, 10; 2d digit, 38; 3d digit, metacarpal, 35.7; 1st phalanx, 15.4; 2d phalanx, 19; 4th digit, metacarpal, 37; 1st phalanx, 10; 2d phalanx, 12.7; 5th digit, metacarpal, 37; 1st phalanx, 11.8; 2d phalanx, 14; tibia, 20.3; foot 8.5, calcar, 13.

Rhinolophus cornutus Temminck.

Four specimens, in alcohol, from Mt. Fuji, Japan, were presented by Mr. Thomas Barbour. As there are but few published measurements of this species, the dimensions of these four are here given:

MEASUREMENTS OF RHINOLOPHUS CORNUTUS.

No.	Sex.	Total Length.	Tail.	Ear.	Fore-arm.	Thumb.	Second Digit.	Third Digit.	Fifth Digit.	Tibia.	Foot.
6925	♀	—	16.0	15.0	41.5	8.4	32.0	58.5	51.0	17.3	8.5
6926	♂	55	18.4	16.5	40.0	7.4	30.0	56.0	51.8	16.0	7.5
6927	♂	59	19.0	16.8	40.0	8.0	32.6	59.0	54.0	16.4	8.0
6928	♂	58	18.5	16.5	39.0	7.6	31.5	59.0	53.0	17.0	7.5

Rhinolophus euryotis Temminck.

This, the only species of the genus known from Amboina, Moluccas, is represented in the collection by a series of nine alcoholic specimens, collected by Mr. Thomas Barbour. The forearm measurement of these specimens averages about 57.4 mm. (56–58).

HIPPOSIDERIDAE.

Hipposideros diadema (E. Geoffroy).

An adult female from Sarawak, Borneo, No. 5979, alcoholic, measures as follows: head and body, 84; tail, 52; ear, 26.7; forearm, 84.5; thumb, 14 5; 2d digit, 66; 3d digit, metacarpal, 64; 1st phalanx, 29; 2d phalanx, 32; 4th digit, metacarpal, 61; 1st phalanx, 20; 2d phalanx, 17; 5th digit, metacarpal, 56.3; 1st phalanx, 21; 2d phalanx, 20; tibia, 33; foot, 14.3; calcar, 21. Skull: greatest length, 33.5; basal length, 27; interorbital constriction, 4; zygomatic breadth, 19; mastoid breadth, 15.3; mandible, 24; maxillary tooth row (exclusive of incisors), 13.5; mandibular tooth row (exclusive of incisors), 14.7.

Hipposideros vittatus (Peters).

Notwithstanding that this species was described from Ibo Island, Cape Delgado group, three males, Nos. 3297, 3299, 3301, alcoholic, from Zanzibar, seem more nearly allied to it than to any of the other recognized forms of the *gigas* group, of which it is the smallest member. The forearm and the tibia measurements given by Peters are 105 mm. and 40 mm. respectively, which agree well with the corresponding dimensions of our specimens given below.

MEASUREMENTS OF HIPPOSIDEROS VITTATUS.

No.	Head and Body.	Tail	Ear.	Forearm.	Thumb.	Second Digit.	Third Digit.	Fifth Digit.	Tibia.	Foot.
3297	107.0	34.0	31	103.5	20.0	77	147.0	111	39	19.5
3299	101.5	33.0	29	103.0	18.6	76	141.5	111	40	20.0
3301	—	38.6	30	105.4	20.0	78	146.0	112	40	20.0

The skull of No. 3299 measures: greatest length, 36.5; basal length, 29.5; interorbital constriction, 3.3; zygomatic breadth, 20; mastoid breadth, 17.5; height of sagittal crest, 5; mandible, 24.6; maxillary tooth row (exclusive of incisors), 12.3; mandibular tooth row (exclusive of incisors), 14.

PHYLLOSTOMIDAE.

Micronycteris minuta (Gervais).

This species was originally described from Brazilian specimens, and is well characterized by its short thumb and calcar, greater emargination of the interfemoral membrane, and very small second lower premolar, as compared with *M. megalotis*, with which it is found associated in Brazil. A specimen in alcohol, No. 4153, ♀, from Lagoa Santa, Brazil, measures as follows: head and body, 47; tail, 9.3; ear, 19.6; forearm, 34.4; thumb, 7.6; 3d digit, metacarpal, 27; 1st phalanx, 10.5; 2d phalanx, 12; 3d phalanx, 9.8; 4th digit, metacarpal, 28; 1st phalanx, 8; 2d phalanx, 10; 5th digit, metacarpal, 28.5; 1st phalanx, 8.5; 2d phalanx, 7.7; tibia, 13; foot, 8.5; calcar, 7.5. Skull: greatest length, 18; basal length, 14; interorbital constriction, 4; zygomatic breadth, 8; mastoid breadth, 8.6; mandible, 11; maxillary tooth row (exclusive of incisors), 6; mandibular tooth row (exclusive of incisors), 7. A young female, No. 4944, from Pernambuco, Brazil, still retains both upper and lower milk canines and the upper milk incisors, in addition to the permanent teeth.

Phyllostomus hastatus (PALLAS).

The geographic variation of this species in the matter of size has led to the recognition of at least two races in northern South America and Panama. I therefore append the measurements of three Brazilian specimens, No. 3983 from Rio Janeiro, Nos. 4080, 4085, from Rio das Velhas, as an aid to the further definition of the precise range of the typical subspecies.

MEASUREMENTS OF PHYLLOSTOMUS HASTATUS.

No.	Head and Body.	Tail.	Ear.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Calcar.
3983	107.0	17.0	32	87	16.0	162	108	31.5	21	22
4080	107.0	20.5	30	82	17.0	164	107	30.6	20	23
4085	108.5	21.0	33	83	16.5	154	105	29.0	19	21

The skull of No. 3983 measures: greatest length, 39.4; basal length, 31; interorbital constriction, 7.3; zygomatic breadth, 21.5; mastoid breadth, 21; mandible, 26; maxillary tooth row (exclusive of incisors), 18.6; mandibular tooth row (exclusive of incisors), 15.4.

Phyllostomus hastatus panamensis J. A. ALLEN.

I have referred to this race five well-made skins with skulls from Boruca, Costa Rica. Their measurements correspond fairly well with those given by Dr. J. A. Allen for the type, from Chiriqui, Panama.

MEASUREMENTS OF PHYLLOSTOMUS HASTATUS PANAMENSIS.

No.	Forearm.	Third Digit, Metacarp.	First Phalanx.	Second Phalanx.	Fifth Digit, Metacarp.	First Phalanx.	Second Phalanx.
12,312	87.0	85.0	21.0	43.5	79.0	17.0	18.5
12,313	87.0	81.0	20.4	40.5	78.0	15.7	18.0
12,314	94.5	83.5	21.0	43.0	78.0	16.5	20.0
12,315	92.0	84.0	20.0	42.0	76.8	16.0	18.0
12,316	94.0	83.0	21.0	43.0	80.0	16.5	19.0

These specimens represent a reddish and a black phase, with one individual intermediate.

Glossophaga soricina (Pallas).

Three specimens from Zorritos, Peru, are a very little larger than others from Panama and Venezuela. Two of these are in the collection of the Peabody Museum, Yale University, and the third is No. 6994, Museum of Comparative Zoölogy. The forearms measure 36.4, 38.5, and 37 mm. respectively, thus about equalling that of *G. longirostris*, from which, however, the Peruvian bats are very different in cranial characters. Additional specimens may show that the Peruvian Glossophaga is a distinct race.

Glossophaga longirostris Miller.

In addition to the type from the Santa Marta Mountains, Colombia, the collection contains a large series of skins (without skulls) from Union Island and Carriacou, Lesser Antilles. The younger individuals are of a nearly uniform clove-brown, but the adults become brighter, approaching a Vandyke brown (as in the type) or Mars brown. Ten adults from Carriacou average: forearm, 37.6 mm. (36.5–39); tibia, 15 (14.5–16); these measurements are the same as those of Venezuelan specimens, and are constantly greater than those of the allied *G. soricina* (forearm, 33 mm.; tibia, 13) that occurs with *G. longirostris* in northern South America.

Lonchophylla hesperia, sp. nov.

Type. — Adult male, alcoholic, No. 7011, Museum of Comparative Zoölogy; collected at Zorritos, Peru, by F. H. Bradley.

General Characters. — Apparently similar to *L. mordax* Thomas, but larger throughout.

Description. — The color of the fur cannot now be determined accurately, as the specimens examined have been in alcohol for many years; both above and below the bases of the hairs are pale tipped with darker. Thomas states that in the allied species, *L. mordax,* the hairs are cinnamon-brown above and wood-brown below, with whitish bases.

Both above and below the fur of the body extends out on the membranes as far as a line drawn from the middle of the humerus to the middle of the femur; a few scattered minute hairs on tibiae, toes, and lower surface of the interfemoral membrane.

Ear oval, the inner margin slightly convex to the broadly rounded-off tip. Outer margin very slightly concave from the tip to the middle, thence slightly convex to the shallow basal notch, which is succeeded by a low rounded lobe. Tragus tongue-shaped, pointed, its inner margin thickened; a small notch cuts off a basal lobe externally. Nose leaf triangular, slightly higher than broad, sides slightly concave at the upper third. Wings from the tarsus; interfemoral with its free edge slightly emarginate. Tail included in the basal third of interfemoral, but tip free on upper surface.

The lower lip is marked by a deep triangular median furrow, the sides of which are bordered by about five small rounded lobules, the distal of which is expanded laterally into a thin flat plate. The shape of this expansion is not the same in all the specimens, and it may be partially divided by a shallow notch of varying depth. In the alcoholic specimens of Glossophaga examined, the lobules or papillae bordering the labial groove are all small and roundish, and do not show the expansion found in the terminal ones of Lonchophylla. Thomas (Ann. Mag. Nat. Hist., 1903, ser. 7, vol. 12, p. 459) in his description of the genus, was unable to determine whether or not the labial groove was present, as his specimens were all dried skins. The Peruvian species, however, shows this groove, as well as the peculiarities of the bordering papillae which may prove to be of generic value. (Pl. **1**, Fig. 7)

Skull and Teeth. — The skull is long, with a narrow rostrum, and the lower jaw projects beyond the upper incisors. The symphysis is sharply keeled; zygomata incompletely ossified. The lower incisors form a slightly convex row, and the outer ones on each side do not quite touch the canine. Lower canines simple and slender, but the upper canines have a very distinct postero-internal cingulum cusp, which does not seem to have been previously noticed in the genus. Upper and lower premolars slightly spaced, though the first lower premolar is practically in contact with the canine. Both the upper premolars and the second and third lower ones have each a slight cingulum cusp anteriorly and posteriorly.

Measurements. — External measurements of the type: head and body, 60; tail, 9; depth of interfemoral, 21; forearm, 38; thumb, 9; 2d digit, metacarpal, 35; 3d digit, metacarpal, 41; 1st phalanx, 12; 2d phalanx, 20.6; 3d phalanx and tip, 8.5; 4th digit, metacarpal, 35.6; 1st phalanx, 9.5; 2d phalanx and tip, 12; 5th digit, metacarpal, 35.5; 1st phalanx, 9.7; 2d phalanx and tip, 11.5; tibia, 14; foot, 8; calcar, 8.8; ear from meatus, 14.5; tragus, 5.7; nose leaf from lip, 8.

Skull: greatest length, 28; basal length, 24.8; palatal length, 16; interorbital constriction, 4.7; breadth outside first molar, 5.6; mastoid breadth, 10; greatest breadth of brain case, 9.5; mandible, 20.3; maxillary tooth row (exclusive of incisors), 9; mandibular tooth row (exclusive of incisors), 9.4.

Remarks. — I am indebted to Professor A. E. Verrill, of Yale University, for the privilege of describing this species. The original lot contained three specimens, all from Zorritos, and one of these, the type, has been presented to the Museum of Comparative Zoölogy; the two others are in the Peabody Museum at Yale. The type is slightly the smallest of the three; the forearms of the two others measure 39.6 and 40.6 mm. respectively. The forearm of *L. mordax*, described by Thomas from Bahia, Brazil, is given as 34 mm., "all the specimens about the same," and the other measurements are correspondingly smaller in the eastern animal (3d digit, metacarpal, 31; 1st phalanx, 11.3; 5th digit, metacarpal, 29; 1st phalanx, 8.5; greatest length of skull, 23.7). It is not unlikely that further research will discover intergrades from the region between Peru and the Brazilian coast; but in the absence of these, the Peruvian bat may for the present stand as a full species. Additional measurements of the two other specimens at the Peabody Museum, New Haven, follow (original numbers are illegible):

MEASUREMENTS OF LONCHOPHYLLA HESPERIA.

Head and Body.	Tail.	Fore-arm.	Thumb.	Third Digit.	Fourth Digit.	Fifth Digit.	Tibia.	Calcar.	Ear.
65	13.0	40.6	8.5	84	59.5	57.5	15.0	9.5	15
62	10.5	39.6	9.0	82	60.5	55.0	14.8	8.5	16

The tongue of the second specimen projects 21 mm. beyond the nose.

Anoura geoffroyi Gray.

A small series of adults and young was collected at Texolo, Vera Cruz, Mexico, on March 15, 1899.

Lonchoglossa caudifera E. Geoffroy.

A series of five alcoholic females from Rio Janeiro, Brazil, shows an interesting variation in the development of the rudimentary tail. In Nos. 4000 and 4001 it distinctly projects just beyond the free border of the uropatagium, and consists in the former of four vertebrae (outside the body), the terminal one of which is much shorter than the others, and whose combined length is 4 mm. In No. 4006 the tail is about 3.5 mm. long outside the body, and only reaches to within about 1 mm. of the free border of the interfemoral membrane; it, too, seems to consist of four vertebrae in the membrane, the terminal one of which is smallest and apparently somewhat cartilaginous. In No. 3984 the tail is still further reduced, and extends to within but 3 mm. of the free edge of the membrane, and only three external vertebrae are with certainty distinguishable.

Vampyrops lineatus (E. Geoffroy).

A series in alcohol from eastern Brazil (Bahia, Macaco, Minas Geraes) is referred to this species. The average forearm measurement of nine individuals is 47.7 mm., which closely approximates that (46 mm.) given by Lyon for a specimen from Paraguay, the type locality.

Vampyrodes major, sp. nov.

Type. — Adult female, alcoholic, No. 6756, Museum of Comparative Zoölogy; collected at San Pablo, Isthmus of Panama, by Allen Lesley.

General Characters — Allied to *Vampyrodes caracciolae* Thomas, but larger throughout.

Description of Type. — It is now impossible to say what was the original color of the type, as it has been preserved in spirits for a number of years. The color of the fur *in alcohol* is burnt umber dorsally, similar but paler below. Two broad white stripes, starting one on each side of the nasal eminence, and 4 mm. apart at their origin dorsally, pass backward slightly above the eye to the upper posterior root of the ear. These stripes are about 3 mm. broad throughout. A second white stripe, less well defined, runs from below the anterior corner of the eye on each cheek to the outer base of the ear. A very narrow white stripe runs medially from the occiput to the end of the spine. Tips of the wings whitish.

Dorsally the fur extends out on the wing membranes as far as a line joining the elbow and the knee and along the dorsal surface of the forearm. There is a slight pubescence at the base of the thumb. The hind limbs are practically naked save for a few scattered short hairs; interfemoral membrane with a few long hairs from the median border; inferior surfaces of the membranes naked; base of the ears, posteriorly, covered with fur, and a thin tuft of long hairs on the inner anterior margin of the conch.

Nose leaf well developed, its anterior border free, horseshoe-shaped; the erect portion broadest at the base, tapering to the pointed summit, and with a central thickened, mitre-shaped area. On the lower lip is a large median glandular swelling, rounded, with a smaller oval swelling at each side at the edge of the lip. A row of five or six small roundish glands runs from the edge of the lip on each side down below the large central gland. A curved glandular swelling is present at the base of the nose leaf on each side.

Inner margin of ear, regularly convex, summit rounded and somewhat flattened; upper half of outer margin nearly straight; lower half convex to the basal lobe, whose outline is nearly semicircular but flattened. The outer basal three-fourths of the ear-conch is provided with about a dozen transverse rugae. Tragus thick, acuminate, triangular in section, with a basal lobe, succeeded distally by a deep notch.

Measurements. — External measurements of the type: length of head and body, 76; eye to nostril, 7; ear from meatus, 20.5; ear from crown, 13.5; tragus, 6; forearm, 55.5; thumb, 15.3; 2d digit, metacarpal, 45; 3d digit, metacarpal, 54; 1st phalanx, 20; 2d phalanx, 30; 3d phalanx and cartilaginous tip, 17; 4th digit, metacarpal, 53; 1st phalanx, 16; 2d phalanx and tip, 21; 5th digit, metacarpal, 54.5; 1st phalanx, 12.4; 2d phalanx and tip, 17.5; tibia, 18.5; foot, 14; calcar, 6; nose leaf, greatest length, 12.4; greatest width, 7; width of interfemoral membrane medially, 6.5.

Skull and Teeth. — The skull is of the Vampyrops type, with broad short muzzle and narrow braincase, with an evenly convex profile. The sagittal crest is only slightly developed. Dental formula:

$$I\,\frac{2-2}{2-2},\ C\,\frac{1-1}{1-1};\ PM\,\frac{2-2}{2-2},\ M\,\frac{2-2}{3-3}.$$

The suppression of the metacone in the second upper molar gives that tooth a very flat appearance in side view as contrasted with the first upper molar. The skull of the type measures: greatest length, 29; basal length, 22.8; interorbital constriction, 7; greatest width outside second upper molar, 13; palatal length, 15; zygomatic breadth, 18.5; mastoid breadth, 14.3; mandible, 20; maxillary tooth row (exclusive of incisors), 10.5; mandibular tooth row (exclusive of incisors) 11.6.

[illegible]s. — Hitherto but one species of the genus Vampyrodes has been recognized, V. *caracciolae* (Thomas). This was described from a Trinidad specimen, which probably represents an island form. I have found no record of additional specimens from Trinidad, and its presence on the mainland of South America seems hitherto to have escaped notice. It is therefore of especial interest to find this larger representative of the genus in Panama. In addition to its greater size, there seem to be color differences as well, for Thomas does not mention the short inferior cheek stripe that is present in our specimen.

Artibeus planirostris (Spix).

In an adult male specimen from Bahia, Brazil, the evanescent third upper molar usually found in this species is absent on both sides, though in a second specimen from the same locality and a third from Rio Janeiro this tooth is present. No doubt the absence of this small molar in two specimens (Nos. 10,454, 10,455) from Bogaba and Boquete, Panama, respectively, led to their identification as young of *Artibeus intermedius* (Bangs, Chiriqui Mammalia. Bull. Mus. Comp. Zoöl., 1902, vol. 39, p. 50), with the description of which they seemed to agree fairly well. As stated by Mr. Bangs, however, both specimens are quite adult, and a more recent comparison with specimens of the two species shows conclusively that they are simply adults of *planirostris* that have lost the small upper third molar. Rehn (Proc. Acad. Nat. Sci. Phila. for 1900, 1901, p. 756) mentions a Brazilian bat of this species that lacked the last upper molar on but one side, and a second that had lost both these teeth. No doubt they are commonly deciduous in adults. For comparison with specimens from other localities, I have appended the external measurements of two alcoholic specimens, Nos. 197, 3076, from Bahia, Brazil (the type locality), and a third, No. 3854, from Rio Janeiro, Brazil, all in the Museum collection.

MEASUREMENTS OF ARTIBEUS PLANIROSTRIS.

No.	Head and Body.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Calcar.	Nose Leaf.	Ear.
197	76	64.0	14.7	130.0	88.5	25.0	15.5	8.0	12.4	23.0
3076	74	63.0	15.2	125.5	90.0	23.0	13.0	8.0	12.2	22.3
3854	—	61.5	16.0	122.5	86.0	22.5	13.5	7.5	12.0	22.5

The following measurements are from the skull of No. 197, adult male, from Bahia: greatest length, 31.6; basal length, 25.5; palatal length, 16.3; interorbital constriction, 7; zygomatic breadth, 19; mastoid breadth, 17; mandible, 22.5; maxillary tooth row (exclusive of incisors), 11.5; mandibular tooth row (exclusive of incisors), 13; palatal width outside first molar, 14.3.

Artibeus grenadensis (Andersen).

Artibeus planirostris grenadensis Andersen, Ann. Mag. Nat. Hist., 1906, ser. 7, vol. 18, p. 420.

Mr. K. Andersen has recently named the island form of the *planirostris* group occurring on Grenada, but gives only the briefest diagnosis and no measurements. Two skins in the collection, taken at St. George, Grenada, are uniformly darker than specimens of *planirostris* from the neighboring mainland, nearly Prout's brown instead of clove brown, and are quite without indication of facial stripes. Their size is slightly less throughout than in continental *planirostris* from the type locality and from Panama. The skulls of the Grenada Artibeus are also smaller with slightly lighter dentition, and the second lower molar is very noticeably shorter.

In one of our specimens the minute third upper molar is present, but in the other it is lacking on the left side, although the empty socket is still visible. In view of the marked differences as compared with its nearest geographical relatives, and its probable limited range, this form may stand as a species.

Artibeus jamaicensis Leach.

A single skin of this species from Kingston, Jamaica, measures as follows: head and body (collector's measurement), 86; ear, 18; forearm, 58; thumb, 14; 2d digit, metacarpal, 44; 3d digit, metacarpal, 53; 1st phalanx, 16.5; 2d phalanx, 27; 4th digit, metacarpal, 53; 1st phalanx, 14; 2d phalanx and tip, 20; 5th digit, metacarpal, 55; 1st phalanx, 11; 2d phalanx and tip, 16; foot, 16.5; calcar, 7.

The Jamaican Artibeus seems more nearly allied to those of the *planirostris* group from its small size, indistinct facial stripes, and the minute grayish tipping of the body hairs, and differs greatly in general appearance from the larger *intermedius* and *palmarum* in which the facial stripes are more clearly defined and the frosting of grayish tips is absent.

Artibeus lituratus (Lichtenstein).

Mr. Oldfield Thomas (Ann. Mag. Nat. Hist., 1901, ser. 7, vol. 8, pp. 192, 441) has revived Lichtenstein's name for the large Artibeus of southern Brazil, but no measurements seem available in recent literature. I have therefore included the measurements of three adults, Nos. 188, 1277, 5004, taken at Rio Janeiro, Macaco, and near Santarem, Brazil, respectively. These specimens, with four others from Brazil, are preserved in alcohol.

MEASUREMENTS OF ARTIBEUS LITURATUS.

No.	Head and Body.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Calcar.	Nose Leaf.	Ear.
188	80	72.5	18.5	142	94	25	17.0	8.5	13.5	22
1277	88	74.0	17.0	155	106	27	17.3	9.0	13.3	24
5004	82	70.5	17.0	146	103	25	18.0	9.0	14.0	23

The skull of No. 5004 measures: greatest length, 31; basal length, 24.2; palatal length, 15; interorbital constriction, 7; zygomatic breadth, 18.5; mastoid breadth, 17; mandible, 21.5; maxillary tooth row (exclusive of incisors), 11; mandibular tooth row (exclusive of incisors), 12; palatal width outside first molar, 13.4.

Artibeus intermedius J. A. Allen.

Four skins and skulls of this bat have recently been received from Boruca, near San José, Costa Rica (the type locality). These, with one exception, are adults and agree in being uniformly broccoli brown or drab above, and nearly Prout's brown below, with a narrow facial stripe on each side from near the posterior base of the nose leaf to the ear. The forearm measurements of three of these specimens are 65, 70, 71.5 mm., respectively, or a trifle larger than that given for the type (65 mm.). The hair is nearly uniform in color to the base instead of having lighter bases as in *A. jamaicensis* and *A. planirostris*.

Artibeus palmarum Allen and Chapman.

This is a distinctly larger species than *intermedius*, without the bluish cast to the fur; it also seems to be decidedly more of a russet when adult. No. 10,471, adult female from Bogaba, Panama, is the specimen referred to as *A. intermedius* in Bull. Mus. Comp. Zoöl., 1902, vol. 39, p. 50, but a comparison with Costa Rican specimens shows that it is not that species. No doubt the range of *A. palmarum* is more southern, from Panama eastward along the northern coast of South America. The type specimen of *A. femur-villosum* Bangs is also in the Museum collection, and as pointed out by Dr. J. A. Allen (Bull. Amer. Mus. Nat. Hist., 1900, vol. 13, p. 89), is clearly *A. palmarum* as at present understood. This specimen is from La Concepcion, Colombia, and the name might therefore be applicable to the continental form, should it prove eventually to be distinct from that of Trinidad. The difference in size between *A. palmarum* and *A. intermedius* may be inferred from the fact that the third metacarpal of three specimens (from Bogaba, Panama, and La Concepcion, Colombia) averages 66.6 (65–68.8), as against 62.7 (62–66) for four Costa Rican *A. intermedius*. Unfortunately the forearms are broken in the skins of two of our adult *palmarum*. In one from Panama, however, this bone is entire and measures about 77 mm.

THYROPTERIDAE.

Thyroptera albiventer (Tomes).

The status of this species has hitherto been doubtful, and Miller in his recent synopsis of the genera of bats (Bull. 57, U. S. Nat. Mus., 1907, p. 192) says that but "two species are now recognized," *viz.*, *T. tricolor* of Brazil, and *T. discifera* of northern South America and Central America. The same writer in a previous paper (Proc. Biol. Soc. Washington, 1896, vol. 10, p. 109–112) summarized the characters wherein the four described species are supposed to differ, but through a lack of specimens was unable to determine the validity of any but *T. discifera*. The Museum collection contains a mounted specimen (No. 6277) of this genus from "Ecuador" that appears to be *T. albiventer* of Tomes, whose type came from the Rio Napo, near Quito, Ecuador. It differs from *T. discifera*, its probable nearest ally, in the color of the fur, which is about a Vandyke brown dorsally, but below, that of the chin, throat, and central parts of the chest and abdomen is whitish throughout, while that of the sides is a light Vandyke brown basally, with whitish tips. In a specimen of *T. discifera* from San Julian, Venezuela, the entire pelage is Vandyke brown, not darker at the bases of the hairs, while in our specimen of *T. albiventer* the hairs are slightly darker at their bases than at their tips. This specimen does not seem to have become faded appreciably, notwithstanding its exposure in an exhibition case. The tail, as in *T. discifera*, extends apparently just beyond the posterior border of the interfemoral membrane, thus differing from *T. tricolor*, in which from "one fourth to one third" is free from the interfemoral membrane. The third and fourth digits of the pes appear to show syndactylism, as in *T. discifera*, though in the specimen as mounted this is a trifle difficult to determine. The measurements of our Ecuadorean specimen are not sensibly different from those of *T. discifera*.

VESPERTILIONIDAE.

Myotis adversus (Horsfield).

A single female, alcoholic, No. 6869, was collected by Mr. Thomas Barbour at Buitenzorg, Java, and by him presented to the Museum. It measures as follows: head and body, 46; tail, 38; ear, 16; tragus, 6.6; forearm, 37; thumb, 6; 2d digit, metacarpal, 32; 1st phalanx, 3.6; 3d digit, metacarpal, 36.6; 1st phalanx, 14.5; 2d phalanx and tip, 19; 4th digit, metacarpal, 35; 1st phalanx, 10; 2d phalanx and tip, 11; 5th digit, metacarpal, 34; 1st phalanx, 8; 2d phalanx and tip, 9; tibia, 16; foot, 10; calcar, 14. Skull: greatest length, 15.5; basal length, 12.7; palatal length, 8; interorbital constriction, 3.5; zygomatic breadth, 9.4; mastoid breadth, 7.8; mandible, 11; maxillary tooth row (exclusive of incisors), 5.8; mandibular tooth row (exclusive of incisors), 6.1. The large foot of this species is in marked contrast to the small delicate pes of *M. muricola*, which also occurs at Buitenzorg.

Myotis goudoti (Smith).

The collection contains two alcoholic females from Madagascar, Nos. 5986, 5987, whose measurements, on account of the paucity of such data, are here given, the second measurement in each case being that of No. 5987: head and body, 44, 44; tail, 40.5, 42; ear, 17, 16; tragus, 6.5, 6; forearm, 41, 38.5; thumb, 7.7, 8.2; 2d digit, metacarpal, 37, 34; 3d digit, metacarpal, 38, 35; 1st phalanx, 13.6, 12; 2d phalanx and tip, 19.6, 19; 4th digit, metacarpal, 38, 34; 1st phalanx, 10.5, 10; 2d phalanx and tip, 11, 10; 5th digit, metacarpal, 36, 33.5; 1st phalanx, 9, 9; 2d phalanx and tip, 9, 9.8; tibia, 17, 16; foot, 10.6, 9; calcar, 13.8, 14.2. The skull of No. 5986 measures: greatest length, 15.5; basal length, 13; palatal length, 8; interorbital constriction, 3.5; zygomatic breadth, 9.8: mastoid breadth, 8; mandible, 11.5; maxillary tooth row (exclusive of incisors), 6; mandibular tooth row (exclusive of incisors), 6.2.

Myotis muricola (Hodgson).

Two specimens from Sarawak, Borneo, are referable to this species, as well as a series of fourteen from Batavia and Buitenzorg, Java, collected by Mr. Thomas

Barbour. The measurements of these bats are essentially the same as those recorded by Miller (Proc. U. S. Nat. Mus., 1903, vol. 26, p. 473) for a series from Simalur Island, near Sumatra.

Myotis lucifugus (Le Conte).

The collection contains a large number of specimens from many localities, including Bay St. George, Newfoundland; Restigouche, New Brunswick; Okanogan and Vernon, British Columbia; and Salt Lake, Utah. This is the common bat of the limestone caves of Kentucky, Indiana, and other adjoining States, where immense numbers are known to spend the winter. Notwithstanding Miller's statement that "the skull of *M. subulatus* does not closely resemble that of *M. lucifugus*," it is nevertheless true that specimens of these two common and nearly related species of eastern and central North America are sometimes difficult to distinguish from each other, especially if unaccompanied by skulls. In addition to the longer ears and longer, more sharply pointed tragus of *subulatus*, however, I have found a very constant and useful difference in the lengths of the metacarpal bones. In *M. lucifugus* the third metacarpal is longest, and forms with the fourth and fifth a graduated series. Usually each of the two latter bones is conspicuously shorter than the one preceding it, although in some individuals this difference is slight. In *M. subulatus*, however, the gradation is absent in the specimens that I have examined, with but two exceptions: a specimen from an unknown locality, with a slight gradation of the metacarpals; and a second, locality unknown, in which this feature is more pronounced. It is not unlikely that in case of these two allied species, inhabiting much the same extent of territory, hybridization should occasionally take place. Three or four specimens in the collection are possibly hybrids between these two species. Thus No. 4423, from Missouri, has a large ear for *lucifugus* (length from meatus 16 mm., tragus, 7), though somewhat smaller than that of *subulatus*. The mandibular tooth row measures 7.3 mm., which is practically the same as for *subulatus* (as against 6–6.6 for *lucifugus*); the metacarpals are, further, intermediate in that the fourth and fifth, though both shorter than the third, are *equal*.

Myotis californicus (Audubon and Bachman).

The presence of this species in Colorado has only recently been established, although I find in the collection a skin with skull from Colorado City, Colo., that was taken August 2, 1871. There is likewise a second specimen labelled "Colorado." Two skins were collected in August, 1905, in Chihuahua, Mexico, by the John E. Thayer Expedition.

Myotis nigricans (Wied).

A considerable series of this bat from eastern Brazil, the type locality, has made it possible to compare typical specimens with alcoholics from Santa Marta, Colombia, and from Panama. Those from northern South America seem identical in all respects with the Brazilian individuals. The second premolar of both jaws usually tends to be drawn in slightly from the tooth row. In one specimen, No. 4286, from Lagoa Santa, Brazil, the second lower premolar of the left side is lacking, and the corresponding upper premolar is somewhat reduced in size. In No. 8061, from Santa Marta, Colombia, the minute second premolar is lacking from the right maxillary row, and the first premolar stands nearly in the centre of the space between the third premolar and the canine. The tendency to lose this almost non-functional tooth is of interest as showing the probable future course of evolution, and a similar tendency is well known in various species of bats in case of these and other teeth.

Myotis subulatus (Say).

A skin with skull from Chihuahua, Mexico, was collected August 10, 1905, by the John E. Thayer Expedition, and seems typical in every way. The collection also contains specimens from Grand Menan, N. B., and Lake Edward, Quebec, to Arkansas. The possibility of hybridization occurring between this species and *M. lucifugus* has been mentioned under the latter.

Pipistrellus abramus (Temminck).

This species is common and generally distributed in southeastern Asia. Mr. Thomas Barbour collected a large series at Buitenzorg, Java, and also obtained four in alcohol from Oshima, Loo Choo Islands, and one from Yokohama, Japan. This bat has not previously been recorded from the Loo Choos. The Javan series shows more or less individual variation. The forearm measurement of twenty-five specimens averages about 34.7 mm. (32.6–36.5). The outer upper incisor usually just exceeds the cusp of the inner incisor in vertical extent, but is worn down more rapidly than the latter, so that in old skulls it is distinctly shorter than the cusp. In one case, however, the outer upper incisor is distinctly shorter than the cusp of the inner, although the teeth are apparently unworn. An adult female from Buitenzorg contained two large fetuses.

Pterygistes lasiopterus (Schreber).

Three adults in alcohol were obtained from Hondo, Japan, by Mr. Thomas Barbour, and by him presented to the Museum. Japanese and Chinese specimens are both currently referred to *lasiopterus*, but I have had no opportunity to compare the insular with continental examples. The dimensions of these specimens are here given.

MEASUREMENTS OF PTERYGISTES LASIOPTERUS.

No.	Head and Body.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Calcar.	Ear.
6929	82.0	60.0	9.5	111	65.5	22	11.0	24	18.0
6930	88.0	62.0	10.5	113	67.0	22	11.0	25	17.6
6931	81.5	60.5	10.0	107	65.5	22	11.7	21	19.0

The skull of No. 6929 measures: greatest length, 22; basal length, 19.8; palatal length, 11; interorbital constriction, 5.6; mastoid breadth, 13; mandible, 17.2; maxillary tooth row (exclusive of incisors), 8.6; mandibular tooth row (exclusive of incisors), 9.3.

Eptesicus nasutus (Dobson).

This species seems to be rare in collections. A skin with skull from Amballa, India, agrees almost exactly with the measurements given by Dobson for the type from Scinde, India. He states, however, that the wing and interfemoral membranes are almost naked, but in our specimen the interfemoral is thinly haired from the knee about to the end of the third caudal vertebra. The following measurements are from the skin, No. 5147, from Amballa: forearm, 37; third finger, metacarpal, 34.5; 1st phalanx, 13; 2d phalanx, 11; 4th digit, metacarpal, 35; 1st phalanx, 12; 2d phalanx, 8; 5th finger, metacarpal, 34; 1st phalanx, 9; 2d phalanx, 6; tibia, 14; foot, 7.

The skull approaches that of Vespertilio in the rather strongly marked concavity between the orbit and the nares on each side, but the nasal emargination is shallow, as in other members of the genus Eptesicus. The dimensions of the skull are: total length, 14.2; basal length, 13; palatal length, 7.5; interorbital constriction, 3.7; zygomatic breadth, 9.3; mastoid breadth, 8; mandible, 10.5; maxillary tooth row (exclusive of incisors), 5; mandibular tooth row (exclusive of incisors), 5.5.

Scabrifer[1] notius, sp. nov.

Type. — Adult male, alcoholic, No. 4555, Museum of Comparative Zoölogy; collected at Cape Town, Africa, and received from E. L. Layard.

General Characters. — Size as in *S. floweri* (De Winton), but the fur very dark basally, with light tips. The curious wart-like papillae characteristic of this genus are *sparsely* scattered on both surfaces of the humerus, the forearm, finger bones, tail, and tibiae.

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[1] Scabrifer, new name for Rhinopterus Miller, 1906, preoccupied by Rhinoptera Kuhl, 1841.

Description of the Type. — Color of the fur in alcohol dorsally and ventrally nearly mummy brown, lighter, approaching hair brown at the tips. As the type has been immersed in alcohol for many years, it is possible that the fur is still darker in the living animal. The ears and muzzle are pale.

Dorsally the fur covers the body thickly, but is practically absent from the membranes. The bases only of the ears are clothed, and the somewhat swollen muzzle is thinly clad with short minute hairs and sparser longer ones. Ventrally the membranes are likewise naked, save for the proximal half of the tail and interfemoral, which are thinly covered with short hairs.

The ear, laid forward, reaches nearly to the nostril; it is rounded at the inner basal angle, then nearly straight in outline to the broadly rounded tip. Externally there is a slight concavity below the tip, and the lower half is again nearly straight to the basal notch that separates off the low rounded terminal lobe. The tragus is narrow, bluntly pointed, and rather short.

The wing membrane arises from the base of the toes. The calcar is strongly keeled, but without a terminal lobe. The tip of the tail is free for about 2.5 mm. The curious wart-like papillae characteristic of this genus seem much fewer than in *S. floweri* from the Soudan and are practically absent from the membranes, whereas in the latter species the upper side of the forearms, legs, and tail, and all the proximal portion of the wings and interfemoral membrane are thickly studded with them. In the new species there are dorsally some half-dozen papillae on the humerus, a few at the proximal end of the forearm, but a thicker cluster of from 15 to 20 at the distal end of the forearm; a few are also scattered along the metacarpals and phalanges, and on the dorsal surface of the femora, tibiae, and metatarsals, as well as at the region of the joints on the upper side of the tail. Ventrally the distribution of these warts is about the same, but they are more numerous on the humerus and almost wholly lacking on the fingers, tibiae, and tail.

Skull and Teeth. — As stated by Miller, the skull resembles that of a small Eptesicus, and is somewhat flattened, with an almost straight dorsal profile. The inner upper incisors are long and slender with a faint indication of a cusp near the tip, laterally. The outer incisor is not quite half the height of the inner, and like that tooth has a strongly developed cingulum that forms a slight cingulum cusp. The outer cusps of the mandibular molars are long and rather slender.

Measurements. — The external measurements of the type are as follows: head and body, 49; tail, 37; ear, 13.5; tragus, 5; forearm, 35; thumb, 5.3; 2d digit, metacarpal, 30.5; 3d digit, metacarpal, 32.3; 1st phalanx, 12.7; 2d phalanx, 9; 3d phalanx and tip, 7; 4th digit, metacarpal, 32.5; 1st phalanx, 12; 2d phalanx and tip, 8; 5th digit, metacarpal, 32.5; 1st phalanx, 9.2; 2d phalanx and tip, 5.6; tibia, 12.8; foot, 6.

Skull: greatest length, 14.3; palatal length, 6.6; interorbital constriction, 3.6; mastoid breadth, 8; palatal breadth outside second molar, 5.6; mandible, 10.3; maxillary tooth row (exclusive of incisors), 5; mandibular tooth row (exclusive of incisors), 5.5.

Remarks. — *Scabrifer floweri* from the White Nile and Soudan seems to be a pallid species, while the new species here described is dark-furred, with a much less development of the dermal papillae that give an encrusted appearance to those parts where they occur. The two appear not to differ in size.

Tylonycteris pachypus (Temminck).

Seven specimens in alcohol were recently presented by Mr. Thomas Barbour, by whom they were collected at Sindanglaia, Java. The forearm measurement of these bats averages 27 mm. (26.5–27.4).

Scoteinus pallidus (Dobson).

The collection contains a series of skins with skulls from the Koolloo Valley, India.

Pachyotus temminckii (Horsfield).

Most recent writers have considered this Javan species identical with the Indian *P. kuhlii* Leach. A series from Buitenzorg, Java, collected by Mr. Thomas Barbour, shows conclusively, however, that the insular representative constitutes a very distinct species. In alcohol the Javan specimens are darker ventrally than *kuhlii* (apparently olivaceous instead of clear yellowish white); in addition, the measurements are smaller throughout. The measurements of the Javan bats follow.

MEASUREMENTS OF PACHYOTUS TEMMINCKII.

No.	Head and Body.	Tail.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Calcar.	Ear.
6799	67	49	52.0	7.0	84.0	59	18.0	10.0	18.7	14.5
6800	63	46	52.0	7.5	83.0	58	18.8	10.0	17.0	14.5
6801	67	48	54.5	8.6	89.5	61	19.0	10.6	19.0	14.7
6802	62	47	53.0	8.7	88.0	61	19.0	10.3	18.0	15.3
6803	65	50	52.0	8.7	91.5	62	20.0	10.0	20.0	15.0
6804	69	48	54.0	8.0	92.0	64	19.7	9.5	19.5	15.0
6805	64	50	55.5	8.8	92.0	66	20.0	10.5	17.0	15.5

The skull of No. 6803, ♂ adult, measures: greatest length, 20.4; basal length, 17; palatal length, 10.3; interorbital constriction, 5.5; zygomatic breadth, 14; mastoid breadth, 12; mandible, 14.8; maxillary tooth row (exclusive of incisors), 7; mandibular tooth row (exclusive of incisors), 8.

By way of comparison, I give the measurements of an adult female, *P. kuhlii*, No. 6979, from Delhi, India, collected by Mr. Thomas Barbour: head and body, 76; tail, 50; forearm, 56.5; thumb, 9.2; third finger, 99; fifth finger, 69; tibia, 22; foot, 11.5; calcar, 20; ear, 16.5. Skull: greatest length, 22.2; basal length, 18; palatal length, 11; interorbital constriction, 5; zygomatic breadth, 15; mastoid breadth, 12.5; mandible, 16; maxillary tooth row (exclusive of incisors), 8; mandibular tooth row (exclusive of incisors), 9. This specimen is rather small, as the average length of the forearm of eight other specimens from the Koolloo Valley and Delhi, India, is 60 mm. (59–64). In addition to the greater size of the skull and teeth of *kuhlii*, the occipital crest shows a much stronger development than in *temminckii*.

Pachyotus castaneus (Horsfield).

A single specimen, female adult, No. 6933, from Buitenzorg, Java, I have provisionally referred to this species, although it seems a trifle larger than specimens from the Malay Peninsula. It was collected by Mr. Thomas Barbour, and by him presented to the Museum. Bonhote (Proc. Zool. Soc. London, 1900, p. 192) gives the forearm measurement of continental examples as from 49 to 52 mm. (average 50.7), and states that the color is a uniform chestnut all over, not lighter below. Our specimen is somewhat larger than these measurements indicate, and the dorsal fur, in alcohol, is distinctly darker than that of the ventral surface. A series of this bat from Java might show that the insular animal is a distinct species. The measurements of No. 6933 are as follows. External measurements: head and body, 64; tail, 58; ear, 13.5; forearm, 55.6; thumb, 8; 3d finger, metacarpal, 52.5; 1st phalanx, 19; 2d phalanx and tip, 19; 4th finger, metacarpal, 52; 1st phalanx, 15; 2d phalanx and tip, 11; 5th finger, metacarpal, 47.5; 1st phalanx, 10; 2d phalanx and tip, 8.5; tibia, 22; foot, 9.5; calcar, 16.

Skull: greatest length, 21.3; basal length, 17.5; palatal length, 10.7; interorbital constriction, 5.4; zygomatic breadth, 14.5; mastoid breadth, 12.5; mandible, 15; maxillary tooth row (exclusive of incisors), 7.5; mandibular tooth row (exclusive of incisors), 8.5.

Chalinolobus gouldi (Gray).

An old female, No. 745, from Hobertstown, Australia, lacks the small upper premolar on both sides, and thus shows an interesting parallelism with the related African genus Glauconycteris, in which these teeth are now permanently lost.

Plecotus sacrimontis, sp. nov.

Plecotus auritus Peters, Monatsber. königl. preuss. Akad., Berlin, 1880, p. 24 (part); Auct.

Type. — Adult male, alcoholic, No. 6932, Museum of Comparative Zoölogy; collected on Mt. Fuji, Japan, 4 December, 1906, by Alan Owston, and presented by Mr. Thomas Barbour.

General Characters. — Resembling *P. auritus* of Europe, but larger, with a longer and broader skull. The tibia and the thumb are noticeably longer than in *P. auritus*, but the ears are of about the same size.

Description of the Type. — Color, in alcohol, dorsally a uniform brown, nearest to bistre of Ridgway, the bases of the hairs much darker; ventrally the hairs are slate color at the bases, broadly tipped with light smoke gray.

The membranes are naked, but the very large ears are provided with a fringe of short hairs on the basal two thirds of their inner margin and for an equal distance along the keel of the ear conch. There are also a few small scattered hairs at the base of the ear externally, and on the inner face distally. A few stiff appressed hairs cover the back of the foot. About two dozen transverse rugae are present on the exterior two thirds of the ear. The very large tragus is similar to that of *P. auritus*, and bears a few minute scattered hairs on its outer face. Wing membrane from the base of the toes; calcar long and slender, without a keel, and terminating in a small but distinct lobe. The last caudal vertebra is free.

Skull and Teeth. — The skull and teeth are larger throughout than in the European species; the difference in the length is rather more striking than that in breadth. The cranial dimensions are given below.

Measurements. — External measurements (for comparison, the corresponding measurements of *Plecotus auritus*, from Europe, No. 3279, ♂ adult, are added in parentheses after each): head and body, 42 (40); tail, 44 (45); ear, 39 (36); tragus, 15.5 (15); forearm, 40 (39); thumb, 11.7 (7); 2d digit, metacarpal, 34 (32); 3d digit, metacarpal, 34.3 (35); 1st phalanx, 14.4 (14); 2d phalanx and tip, 20.5 (18.5); 4th digit, metacarpal, 35 (34.2); 1st phalanx, 9.5 (9); 2d phalanx and tip, 10 (9); 5th digit, metacarpal, 33.4 (33): 1st phalanx, 9.5 (9.3); 2d phalanx and tip, 10.5 (9.3); tibia, 21 (18.8); foot, 10.6 (7); calcar, 12 (14.5).

Skull: greatest length, 17.5 (16.2); basal length, 14 (13.3); palatal length, 8.2 (7.3); interorbital constriction, 4 (3.7); zygomatic breadth, 9 (8.5); mastoid breadth, 9 (8.6); mandible, 11.5 (10); maxillary tooth row (exclusive of incisors), 5.8 (5); mandibular tooth row (exclusive of incisors), 6 (5.5).

Distribution. — So far as known this bat is confined to Japan.

Remarks. — The longer and larger thumb (Pl. **1**, Fig. 5) of the Japanese Plecotus, without corresponding appreciable increase of length in the other bones of the hand, together with the larger foot, longer tibia, and bigger skull, at once separate this species from *P. auritus* of Europe. According to Dobson (Cat. Chiroptera Brit. Mus., 1878, p. 179) *P. homochrous* from Nepal, Himalayas, has thumbs even shorter than those of *P. auritus*, and is said by Barrett-Hamilton to be a larger animal than *P. puck* recently described by him from Murree, northern India. I have seen no specimens from eastern continental Asia, but it is possible that they are not to be distinguished from Japanese individuals.

Miniopterus schreibersii (NATTERER).

The type locality of this species is Germany, but its range is currently believed to extend eastward to the Pacific Ocean. At least six rather closely related species are described from Africa (*M. dasythrix*, *M. fraterculus*, *M. majori*, *M. manavi*, *M. natalensis*, *M. inflatus*), but some confusion still exists as to the number of Asiatic forms. In Asia, as in Africa, there appear to be a large and a small species living side by side throughout at least a large part of the range of the genus. The series of Asiatic specimens in the Museum collection shows that some at least of the various names given to the eastern representatives of the genus should be recognized as applying to valid species. Thomas (Ann. Mag. Nat. Hist., 1907, ser. 7, vol. 20, p. 197) has recently described *M. schreibersii pallidus* as a pale desert race of the type species, from the south coast of the Caspian Sea, but does not indicate its eastward range. The large form occurring in India may be conspecific with *M. schreibersii*, to which I have provisionally referred a single adult female, No. 3258, from Calcutta. This bat agrees practically in measurements with those given for German specimens, although I have had no opportunity for direct comparison with bats of this genus from Europe. The Calcutta bat measures: head and body, about 61; tail, 58; ear, 12; forearm, 50; thumb, 6; 2d digit, metacarpal, 42; 1st phalanx, 3; 3d digit, metacarpal, 42.5; 1st phalanx, 10.5; 2d phalanx and tip, 39; 4th digit, metacarpal, 40.4; 1st phalanx, 9.5; 2d phalanx and tip, 18; 5th digit, metacarpal, 37.5; 1st phalanx, 9.5; 2d phalanx, 10.3; tibia, 18.5; foot, 10; calcar, 13.5. The skull measures: greatest length, 17; basal length, 14.3; palatal length, 8.1; interorbital constriction, 4; zygomatic breadth, 9.6; mastoid breadth, 9.1; mandible, 13; maxillary tooth row (exclusive of incisors), 6.6; mandibular tooth row (exclusive of incisors), 7.1. Compared with the skull of what is here considered *M. blepotis* from Amboina, that of the Indian specimen is slightly broader, and with the braincase so inflated antero-laterally as to give it a more nearly circular outline when viewed from above, instead of the distinctly oval shape of the other species.

To this species is doubtless referable the large specimen recorded by Dobson (Cat. Asiat. Chiropt., 1876, p. 163) as collected at Isagine, Upper Burmah. Its forearm measurement is given as two inches (51 mm.).

Should it eventually prove that the Indian Miniopterus is distinct from the European, Hodgson's name, *fuliginosus*, may apply to it.

Miniopterus schreibersii japoniae Thomas.

Compared with *M. blepotis*, which appears to be the nearest ally of the Japanese species, *M. s. japoniae* differs strikingly in its large foot and very short, broad ear. The tibia and forearm are also slightly larger, and the thumb is stouter. The differences are absolutely small, but relatively large, and result in a very different appearance of these parts. Two specimens from Mt. Fuji, Japan, measure respectively: forearm, 46.5, 47; ear from meatus, 10, 10.5; tibia, 18, 91; foot, 9, 9.8.

Bonhote has recently described *M. fuscus* from the Loo Choo Islands, but this bat belongs to the group of smaller eastern Miniopteri, and is of a uniform sooty brown to the bases of the hairs. Whether or not there is a representative of the smaller group in Japan, has not yet been ascertained. In Europe the larger group seems to be alone represented.

Miniopterus blepotis (Temminck).

Vespertilio blepotis Temminck, Monogr. Mammalogie, 1835, vol. 2, p. 212, Pl. **53**, Figs. 1, 2.

Miniopterus schreibersii Auct., part.; Dobson, Cat. Asiat. Chiropt., 1876, p. 160; Idem, Cat. Chiropt. Brit. Mus., 1878, p. 348.

Miniopteris blepotis Tomes, Proc. Zool. Soc. London, 1858, p. 121.

Temminck (Monogr. Mammalogie, 1835, vol. 2, p. 212) applied the name *Vespertilio blepotis* to specimens of Miniopterus "tués à Java, à Timor et à Amboine," and he considered Japanese specimens identical with these. He gives the measurements (here converted into millimeters) as: total length, 106.5; tail, 51.8; forearm, 46–48. Farther on he states that females are smaller, with forearm two to three lines shorter, but this statement probably refers to the smaller species that also occurs in Java. Of the latter Mr. Thomas Barbour has recently presented to the Museum three males and three females collected by him at Buitenzorg, Java. The larger species, however, he did not obtain on that island, although he found it on Amboina, considerably to the eastward, where a single adult female was captured in a limestone cave. This bat corresponds closely with the original description, and doubtless represents Temminck's *blepotis*. This name should stand for the large Miniopterus of Java and the islands to the eastward, and possibly west to the southeastern coasts of Asia, for a specimen from Amoy, China, in the mounted collection of the Museum, is externally identical with our individual from Amboina. This latter, an alcoholic, No. 6920, measures as follows: head and body, 53; tail, 55; ear, 13; tragus (inner margin), 5; forearm, 45.5; thumb, 5.8; 2d digit, metacarpal, 39; 3d digit, metacarpal, 40.5; 1st phalanx, 10; 2d phalanx and tip, 39; 4th digit, metacarpal, 38.5; 1st phalanx, 8.8; 2d phalanx and tip, 17.5; 5th digit, metacarpal, 35.2; 1st phalanx, 8.6; 2d phalanx and tip, 9; tibia, 17; foot, 7.5; calcar, 16. The skull measures: greatest length, 16.2; basal length, 14; palatal length, 8.4; interorbital constriction, 3.7; zygomatic breadth, 9.5; mastoid breadth, 8.6;

breadth outside third upper molars, 7.3; mandible, 12.8; maxillary tooth row (exclusive of incisors), 6.7; mandibular tooth row (exclusive of incisors), 7.

Two skins from near Cape York, northern Australia, are almost identical in measurements with the alcoholic specimen of *M. blepotis*, though the tibiae are perhaps a millimeter or two longer. The fur of these specimens is a uniform color throughout, and is nearest Ridgway's seal brown, with, however, a little less of the reddish tint. Leche (Proc. Zool. Soc. London, 1884, p. 53) has recorded under the name *Miniopterus schreibersi blepotis*, some bats of this genus from South Australia, and points out a few characters in which he found them to differ from the European species. The forearm measurement he gives as 45 mm.; that of our two Australian skins is 46 and 46.3 mm. respectively, which is practically that of *M. blepotis* of Amboina. For the present, then, the larger Miniopterus of Australia may be considered as this latter species.

Miniopterus blepotis differs notably from the large Miniopterus of India in its smaller size and the lesser inflation of the anterior portion of the braincase. Although no skins are available for comparison, the color of *M. blepotis* is said to be darker than that of *M. schreibersii.*

Miniopterus, sp.

A large Miniopterus from Queensland, in the mounted collection of the Museum, may be a different species from the large form of the east Asian mainland. Its color, which shows no evidence of fading through exposure in the exhibition case, is a dark seal brown above, slightly paler below. The hair is of the same color from tip to base. Ventrally the fur extends upon the wing membrane as far as a line joining the elbow and the knee. No name seems to be applicable to this bat, should it prove distinct, but in the absence of comparable material I prefer not to name it. The following measurements are from the skin as mounted: forearm, 50; 3d digit, metacarpal, 45; 1st phalanx, 11; 2d phalanx and tip, 37.5; 4th digit, metacarpal, 42; 1st phalanx, 9; 5th digit, metacarpal, 38; 1st phalanx, 13; foot, 9.5.

Miniopterus pusillus Dobson.

Vespertilio blepotis Temminck, Monogr. Mammalogie, 1835, vol. 2, p. 212 (part).
Miniopteris australis Tomes, Proc. Zool. Soc. London, 1858, p. 125 (part).
Miniopterus australis Dobson, Journ. Asiat. Soc. Bengal, 1871, vol. 40, p. 265.
Miniopterus pusillus Dobson, Monogr. Asiat. Chiropt., 1876, p. 162; Cat. Chiropt. Brit. Mus., 1878, p. 351; Bonhote, Novit. Zool., 1902, vol. 9, p. 626.

Among the bats collected by Mr. Thomas Barbour at Buitenzorg, Java, are six specimens of the smaller Miniopterus in alcohol. Temminck, in describing the Javan *M. blepotis*, speaks of smaller specimens which he supposes to have been females of the latter. Dobson later described and named the smaller bat, and in his Monograph of the Asiatic Chiroptera, records specimens from the Nicobar

Islands and from Madras, India. Tomes had previously included under *M. australis* small bats of this genus from "the Indian islands." Recent writers seem to have considered this species identical with the large *M. schreibersii*, although Bonhote refers to *M. pusillus* from the Nicobars as nearest in size to his *M. fuscus* from the Loo Choo Islands.

Our Javan specimens agree with Dobson's description of *M. pusillus*, the type locality of which may be considered the Nicobar Islands. The species is very well marked, with a small, light skull, and narrow rostrum. The sagittal crest is low and ill defined. The external ear is very small, not exceeding the fur of the crown. The following measurements are from the Buitenzorg series:

MEASUREMENTS OF MINIOPTERUS PUSILLUS.

No.	Head and Body.	Tail.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Foot.	Calcar.	Ear.
6914	51.0	50.0	43.0	6.5	81.5	51.5	17.5	8.0	17.0	9.0
6915	49.0	50.0	42.5	6.5	83.0	54.5	17.0	7.0	16.5	9.0
6916	48.0	50.0	42.0	5.5	81.0	52.0	17.0	6.0	18.5	9.0
6917	48.5	48.0	42.8	6.7	82.5	50.0	16.7	8.0	18.0	10.5
6918	49.0	48.5	42.8	6.0	83.0	52.8	17.5	7.7	—	9.5
6919	45.0	49.5	42.5	6.8	81.0	51.5	17.0	7.0	16.0	9.5

The skull of No. 6919 measures: greatest length, 13.7; basal length, 11.7; palatal length, 6.1; interorbital constriction, 4; zygomatic breadth, 7.6; mastoid breadth, 7.8; mandible, 10.2; maxillary tooth row (exclusive of incisors), 5; mandibular tooth row (exclusive of incisors), 5.

It is probable that Tomes's name *tibialis*, based on a small Miniopterus from Amboina, should replace *pusillus* of Dobson on ground of priority. Tomes states that this bat differs from what he considered *blepotis*, "in having the extremity of the tibia perfectly free for nearly a third of its length." This peculiarity, as indeed Tomes himself suggests, is probably due to shrinkage of the membranes in the preservative fluid. Without specimens for comparison, however, it seems better to use the name *pusillus* for the small Miniopterus of the East Indies.

Miniopterus australis Tomes.

Miniopteris australis Tomes, Proc. Zool. Soc. London, 1858, p. 125.

Two specimens of a small Miniopterus in the collection, labelled "Queensland (?)," agree in their dimensions with those given by Tomes for his Australian species. It is the smallest of the eastern species hitherto recognized, and, according to Tomes, is "very similar" in color to *M. blepotis*, but usually with "a more decided rufous tinge," owing to the reddish tips to the hairs. The measurements of our two specimens follow; they are No. 6764, adult female, and No. 6765, adult male, and their respective dimensions are in each case given in this order: head and body, 45, 47.5; tail, 44, 46; forearm, 40, 38.5; thumb, 4.8, 4; 3d digit, metacarpal, 35, 34; 1st phalanx, 8.7, 9.8; 2d phalanx and tip, 31, 31.5; 4th digit, metacarpal, 34, 33.3; 1st phalanx, 7.5, 7.5; 2d phalanx and tip, 15.5, 15.6; 5th digit, metacarpal, 31.5, 31; 1st phalanx, 7.3, 7.5; 2d phalanx and tip, 8, 8.5; tibia, 15.6, 14.7; foot, 7, 7; ear, 9.2, 10. The skull of No. 6764 measures: greatest length, 14; basal length, 12; palatal length, 6.6; interorbital constriction, 3.7; zygomatic breadth, 7.6; mastoid breadth, 7.8; mandible, 10.5; maxillary tooth row (exclusive of incisors), 5.4; mandibular tooth row (exclusive of incisors), 5.8. The rostrum is slightly longer and the braincase smaller and less inflated than in *M. pusillus*, which it nearest approaches in size.

Murina hilgendorfi (Peters).

Among the Japanese bats presented by Mr. Thomas Barbour is an alcoholic male of this species, collected on Mt. Fuji, Japan, December 14, 1906. The type specimen came from Yedo, and is well figured and described by Peters (Monatsber. königl. preuss. Akad. Berlin, 1880, p. 24, plate), but I have found no record of the discovery of other specimens. The measurements of our specimen, No. 6924, follow, and in some cases are accompanied by the corresponding dimensions given by Peters for the type: head and body, 54; tail, 41; forearm, 43 (41); thumb, 12; 2d digit, metacarpal, 36 (34.5); 1st phalanx, 4.5 (4); 3d digit, metacarpal, 40 (38); 1st phalanx, 17 (18); 2d phalanx, 15 (15); 3d phalanx (cartilage), 7.6 (8.5); 4th digit, metacarpal, 37.5 (36); 1st phalanx, 14 (14); 2d phalanx and tip, 12.5 (13.5); 5th digit, metacarpal, 37.5 (37); 1st phalanx, 14 (13.5); 2d phalanx and tip, 13 (12); tibia, 17.8 (17); foot, 8.5; calcar, 13.5 (14); ear, 17.5 (17); tragus, 7.8 (10). The skull measures: greatest length, 20; basal length, 16.2; palatal length, 10.5; interorbital constriction, 5; zygomatic breadth, 11.5; mastoid breadth, 10; mandible, 14; maxillary tooth row (exclusive of incisors), 6.5; mandibular tooth row (exclusive of incisors), 7.

The fur is thick and woolly, and appears to be like that of Peters's specimen, — bright brownish above, and gray-white tipped, with dark bases below.

Kerivoula hardwickii (Horsfield).

A single specimen was obtained by Mr. Thomas Barbour at Buitenzorg, Java.

MOLOSSIDAE.

Chaerephon plicatus (Buchannan).

Mr. Thomas Barbour obtained a fine series, including both sexes, from Buitenzorg, Java. It is a house bat, often found in the interstices of buildings. One specimen, No. 6844, has but two, instead of the usual four, lower incisors. This bat is closely related to the species described by Miller as *jobensis*, from the island of Jobie, northwestern New Guinea, if, indeed, the two are not identical. I have seen no specimens from Bengal, the type locality of *C. plicatus*; but Miller supposes the Indian animal to be larger, as "both Dobson and Blanford give the length of forearm in *N.* [= *Chaerephon*] *plicatus* as 50 mm. (1.95 in.), while in the six *N. jobensis* it ranges from 44 mm. to 46 mm." (Proc. Biol. Soc. Washington, 1902, vol. 15, p. 246.) In our Javan series the forearm measurement varies between 44 and 49 mm.

Molossops planirostris Peters.

A skin and skull from near Panama are in the collection, thus establishing the presence of this species within the limits of Middle America. This is the specimen recorded previously as *Promops nanus* (Bull. Mus. Comp. Zool., 1906, vol. 46, p. 212), a mistake for which I am largely responsible. A comparison with material kindly loaned by the U. S. National Museum, however, leaves no doubt as to the identity.

Nyctinomus brasiliensis I. Geoffroy.

The collection contains a large series of Nyctinomus, both skins and alcoholics, from Texas and Mexico, as well as other spirit specimens from Buenos Ayres and Patagonia. I am unable to discover tangible differences between the alcoholic specimens from the two extremes of the range, and hence follow Miller and Rehn (Proc. Boston Soc. Nat. Hist., 1901, vol. 30, p. 271) in applying Geoffroy's name to the Mexican and Texan bat, rather than that of Saussure (*mexicanus*) employed by Elliot. The following measurements are of Argentine and Texan specimens:

MEASUREMENTS OF NYCTINOMUS BRASILIENSIS.

No.	Locality.	Forearm.	Third Digit.	Fifth Digit.	Tibia.	Skull Length.	Zygom. Breadth.	Mandible.
1203	Buenos Ayres	42.7	82.0	44.7	10.7	17.0	10.0	12.0
3232	Patagonia, S. Matias Bay	41.0	75.5	42.2	10.6	16.6	9.5	11.8
3235	Patagonia, S. Matias Bay	41.6	72.5	40.5	10.7	17.0	—	12.0
6037	Texas	44.0	82.0	45.0	10.7	17.0	10.0	12.0
6040	Texas	42.4	80.5	42.3	10.5	16.8	10.0	11.5

The slightly shorter fingers of the Patagonian bats may be due in part to age, as the specimens seem not fully adult, and in part to their hard and shrunken condition in the preservative fluid. Their skulls are similar to those from Buenos Ayres, Mexico, and Texas. The minute anterior upper premolar varies considerably in shape in different individuals; in some it is a terete spicule, in others the base may be markedly broader. Among twenty-eight specimens from Texas, seven lack the third lower incisor, while in three others that of the right hand side is gone. In three other cases it is the third incisor of the left hand side that is missing. In these individuals there may be a space between the second lower incisor and the canine, as if the third incisor had been shed, or the second incisor may be in close contact with the canine. In one (No. 6057) the third incisor is present on both sides, but is a very minute rounded spicule, to be with difficulty seen by the aid of a lens.

Nyctinomus brasiliensis cynocephalus (Le Conte).

The Nyctinomus of Florida, as pointed out by Miller (Proc. Boston Soc. Nat. Hist., 1898, vol. 28, p. 218), differs from that of Texas and Mexico in its uniformly darker coloration. The back "is intermediate between the 'seal brown' and 'mummy brown' of Ridgway, but nearer the former," while the ventral surface is slightly paler. The hairs are hardly paler at the bases. A series of skins from Texas is distinctly of a lighter tint than the specimens from Florida, with the bases of the hairs grayish, especially about the nape and shoulders. A specimen from Gibson, Ga., is of a reddish tint and much paler than the series of skins from Florida. The latter can hardly be considered more than subspecifically distinct from *N. brasiliensis* of Texas and Mexico.

Nyctinomus antillularum Miller.

The collection contains three alcoholics from St. Kitts, West Indies (included by Miller in the range of the species), and three from St. Bartholomew's Island. In the original description, the forearm of the type is given as 47.4, an obvious misprint for 37.4. Below are the measurements of two specimens (Nos. 6019, 6020) from St. Kitts, and two from St. Bartholomew's Island (Nos. 6023, 6024).

MEASUREMENTS OF NYCTINOMUS ANTILLULARUM.

No.	Head and Body.	Tail.	Fore-arm.	Thumb.	Third Digit.	Fourth Digit.	Fifth Digit.	Tibia.	Foot.	Ear.
6019	54	34.0	38.0	7.5	69.0	58.5	41.0	10.6	6.3	16
6020	53	29.5	36.5	7.0	66.5	56.0	39.0	10.2	6.0	16
6023	52	31.0	39.5	7.0	73.0	61.0	42.0	10.0	6.7	16
6024	52	33.0	39.0	7.0	73.0	61.0	41.5	10.5	6.5	15

Of the specimens from St. Kitts, two lack the third lower incisor on both sides, and one has lost that of the left side. The upper anterior premolar is so minute that except in one of the bats from St. Bartholomew's it cannot be seen until it is uncovered by scraping away the gums.

Molossus obscurus E. Geoffroy.

There still exists some confusion regarding the identity of Geoffroy's *M. obscurus* and its relationship with other closely allied forms. The original description reads as follows: "Pelage brun-noirâtre en dessus, obscur en dessous; les poils étant blancs à leur origine. . . . Le poil n'est brun qu'à sa pointe; en quoi elle diffère principalement des deux précédentes [*M. rufus, M. ater*] qui ont leurs poils d'une seule couleur. Longueur du corps, 0^m, 060 (2 p. 2 lig.); — de la queue, 0^m, 030 (1 p. 1 lig.); — de la membrane interf. 0^m, 023 (8 lig.)." This was one of four species described by Geoffroy from actual specimens in the Paris museum, while the five other species named in the same paper, are based wholly on Azara's descriptions of Paraguayan bats. Geoffroy states that the specimens from which he describes his four first species are from "l'Amérique du nord, de Surinam, et principalement de Caïenne;" he further adds, under *Molossus obscurus:* "Je rapporte à cette espèce la petite chauve-souris obscure, ou la 9^e chauve-souris de M. d'Azzara." The type locality of *M. obscurus* has currently been accepted as Paraguay, where Azara's work was done. A reference to the latter's description, however, makes it clear that his ninth bat (Essais sur l'Hist. Nat. des Quadr. de Paraguay, 1801, vol. 2, p. 288), or "petite chauve-souris obscure" was a Nyctinomus, since "la lèvre supérieure a des plis verticaux" and "les canines, les incisives, et les molaires, sont comme dans la Chauve-souris huitième," identified by Thomas (Ann. Mag. Nat. Hist., 1901, ser. 7, vol. 8, p. 441) as *Nyctinomus laticaudatus.* Of this species Azara says the upper incisors are "avec une séparation," whereas in Molossus they are so closely approximated medially that Azara was misled into supposing that his tenth bat, *Molossus crassicaudatus*, had in the upper jaw "deux canines avec une seule incisive au milieu." Temminck, who examined Geoffroy's type specimen, recognized that it was *not* Azara's ninth bat, and added that "M. Desmarest partage mon opinion" (Monogr. de Mammalogie, 1827, vol. 1, p. 236 and footnote); his description of *M. obscurus* was based on individuals from Surinam, and he mentions that he had seen others from Brazil. The type locality of *M. obscurus* is therefore probably Surinam (one of the localities mentioned by Geoffroy), not Paraguay. The Museum has a series of alcoholic specimens from various localities in northeastern Brazil that are thus practically topotypes, and these agree in measurements with a skin and skull from Goya, Argentina, kindly loaned by the U. S. National Museum. In this skin the hair above is a broccoli brown, paler at the base; and below, a lighter tint of the same. In alcoholic specimens the bases of the hairs are not so conspicuously light as in *M. crassicaudatus.* West Indian representatives of this species from Dominica and Sta. Lucia are a very little smaller than those from Brazil, but the material at hand does not warrant their separation. Of the specimens whose measurements follow, the first is a skin, loaned by the U. S. National Museum.

MEASUREMENTS OF MOLOSSUS OBSCURUS.

No.	Locality.	Head and Body.	Tail.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Ear.
141,530	Argentina, Goya	"73"	"38.0"	41.3	8.0	79.3	45.0	11.8	"14.0"
3063	Brazil, ?Manaos	64	40.0	43.0	7.5	82.0	44.0	12.0	15.0
3936	Brazil, Obydos	63	43.0	42.0	6.8	80.0	42.0	11.5	14.0
4221	Brazil, ?Para	63	36.0	41.0	7.0	80.3	43.5	11.8	15.0
5148	Brazil, Santarem	60	37.0	40.0	7.3	78.5	43.0	11.0	13.5
3930	Brazil, Bahia	61	40.0	41.2	6.5	78.3	42.2	12.0	14.0
6026	W. I., Dominica	58	38.5	40.0	6.8	77.5	40.5	12.0	14.0
6027	W. I., Dominica	56	34.0	39.5	6.0	76.0	41.0	10.5	13.5
6948	W. I., Sta. Lucia	58	36.0	40.3	7.5	78.0	42.0	11.3	13.5
6949	W. I., Sta. Lucia	61	36.7	40.0	6.8	78.0	42.0	11.8	14.0

The skull of No. 3063, from Brazil, measures: greatest length, 19; basal length, 15; palatal length, 7; interorbital constriction, 4; zygomatic breadth, 11.2; mastoid breadth, 11; mandible, 13; maxillary tooth row (exclusive of incisors), 6.7; mandibular tooth row (exclusive of incisors), 7.5. The development of the sagittal crest is subject to considerable individual variation, and in some specimens is hardly noticeable. From the above measurements it is seen that Thomas's *M. obscurus currentium* from Goya, Argentina, is not different from what is here considered typical *obscurus* of eastern and northern South America. The range of this bat appears to be wide, but the status of the various local forms hitherto described seems as yet largely uncertain.

Molossus crassicaudatus E. Geoffroy.

This is certainly a distinct species, and not a race of *M. obscurus* as hitherto supposed. The Museum collection contains specimens from Brazil, Ecuador, Panama, and the Lesser Antilles, and I have examined skins from the type locality, Paraguay. Its range seems nearly coextensive with that of *M. obscurus*. Thomas (Ann. Mag. Nat. Hist., 1901, ser. 7, vol. 8, p. 437) restricted the name *crassicaudatus* to the small Molossus of Paraguay and northern Argentine, and considered it identical with the tenth bat listed by Azara from Argentine, notwithstanding that Geoffroy, in applying the name, gave it to a bat *larger* than his *M. obscurus.* It is not unlikely that *M. obscurus* should rightly refer to this smallest species of the genus, as its forearm corresponds closely in length to the dimension given by Temminck (1 inch, 5 lines), although he may have confused the two. However, as the original descriptions of both species contain nothing that is clearly diagnostic, and as the length of head and body (60 mm.) given by Geoffroy for his *M. obscurus* is obviously more nearly that of the bat that I have referred above to that species, I follow Thomas in the use of the name *crassicaudatus* for the smallest species (forearm, 36–39). Specimens from Villa Rica and Paraguari, Paraguay, loaned me by the U. S. National Museum are very differently colored from skins of *M. obscurus.* They are nearly seal-brown, with the basal half of the hairs sharply grayish-white, on both surfaces. Specimens from St. Vincent and Sta. Lucia, Lesser Antilles, are somewhat darker, but this difference is probably due in part to the method of making up the skin. All agree in having a peculiar gloss to the fur, characteristic of certain other species of the Molossidae. Although the forearm measurement is nearly as great as that of *M. obscurus*, the present species is of strikingly smaller bulk, and the long grayish bases to the hairs, especially of the shoulders and chest, give alcoholic specimens a quite different appearance. The skull is smaller than that of *M. obscurus,* and the sagittal crest is weakly developed, usually only a slight ridge.

MEASUREMENTS OF MOLOSSUS CRASSICAUDATUS.

No.	Locality.	Head and Body.	Tail.	Fore-arm.	Thumb.	Third Digit.	Fifth Digit.	Tibia.	Ear.
114,905	Paraguay, Paraguari	—	"38.0"	37.8	7.0	75	41.0	—	—
114,907	Paraguay, Villa Rica	—	"35.0"	37.6	7.0	77	41.5	11.0	—
3238	Brazil, San Paulo	49	30.5	36.5	5.0	70	36.5	10.0	10.0
3240	Brazil, San Paulo	55	35.0	37.0	6.2	72	39.0	10.8	12.0
3241	Brazil, San Paulo	54	33.6	37.8	5.5	73	38.0	11.5	12.0
3242	Brazil, San Paulo	52	36.0	37.5	5.5	74	38.5	10.8	12.0
6025	W. I., Dominica	52	33.0	36.5	6.5	72	37.0	10.5	12.0
6099	Ecuador, Guayaquil	53	32.0	35.3	6.3	69	36.5	10.2	12.0
6759	Panama, San Pablo	54	30.0	37.0	6.5	72	38.5	10.3	11.5
6760	Panama, San Pablo	53	32.0	37.0	6.0	72	38.5	10.5	11.7

Two specimens, skinned out from alcohol, seem to be this species, and were collected on Margarita Island, Venezuela. They have quite lost the rich gloss seen in fresh skins. Of the specimens whose dimensions are given, the first and second are skins kindly loaned by the U. S. National Museum, and the remainder are alcoholics in the collection of the Museum of Comparative Zoölogy.

Following are the measurements of a skull from Paraguay, No. 114,906, U. S. Nat. Mus., and, in parentheses, of one from San Pablo, Panama, No. 6759: greatest length, 17 (16); basal length, 14 (12.7); palatal length, 6.4 (6); interorbital constriction, 3.7 (3.6); zygomatic breadth, 10.5 (10.2); mastoid breadth, 10.3 (9.6); mandible, 12.1 (11.1); maxillary tooth row (exclusive of incisors), 6 (5.8); mandibular tooth row (exclusive of incisors), 7 (6.5).

EXPLANATION OF PLATE.

Fig. 1. *Pteropus ariel*, dorsal view of skull of type, No. 10,565, Museum of Comparative Zoölogy, from Male Atoll, Maldive Archipelago. Natural size.

Fig. 2. *Pteropus giganteus*, dorsal view of skull, No. 5169, from Koolloo Valley, India. Natural size.

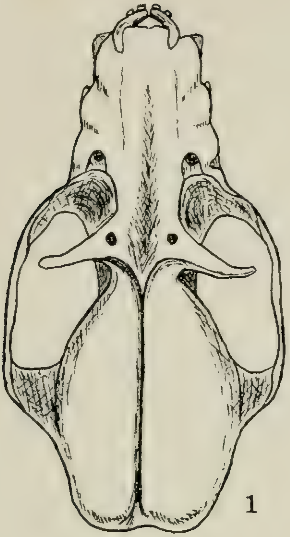
Fig. 3. *Pteropus ariel*, dorsal view of rostrum of an immature individual, No. 10,566, showing the shape of the nasals. Natural size.

Fig. 4. *Pteropus giganteus*, dorsal view of rostrum of an immature individual, No. 5175, from Koolloo Valley, India, to show the elongated nasals. Natural size.

Fig. 5. *Plecotus auritus*, thumb of an European specimen. Natural size.

Fig. 6. *Plecotus sacrimontis*, thumb of the type, No. 6932, Museum of Comparative Zoölogy, from Mt. Fuji, Japan. Natural size.

Fig. 7. *Lonchophylla hesperia*, anterior view of chin, showing enlarged terminal papillae bordering the labial groove. Zorritos, Peru. Enlarged about five times.



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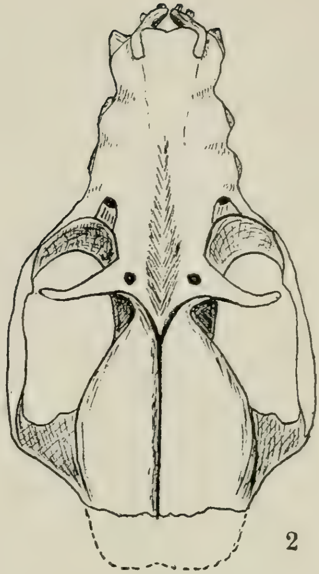

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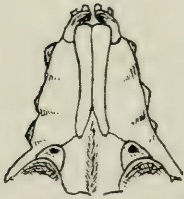

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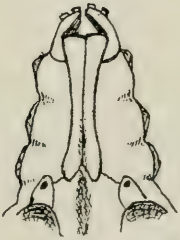

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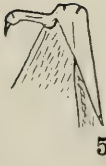

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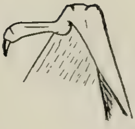

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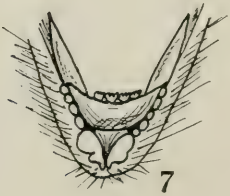

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LII. No. 4.

THE FOSSIL CETACEAN, DORUDON SERRATUS GIBBES.

By Frederick W. True.

With Three Plates.

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No. 4. — *The fossil cetacean, Dorudon serratus* GIBBES.

By FREDERICK W. TRUE.

SOME months ago the authorities of the Museum of Comparative Zoölogy very generously placed in my hands for study the type specimens of the fossil cetacean, *Dorudon serratus*, which was originally described by Dr. R. W. Gibbes in 1845. The material was without any other label than the following: — "This entire lot belongs to the R. W. Gibbes collection, marked 'Eocene' (no locality), but probably South Carolina." A glance at the specimens, however, satisfied me that they included the types of *Dorudon serratus*, and this was confirmed by reference to the original description and figures in the Proceedings of the Academy of Natural Sciences of Philadelphia, 1845, Vol. 2, page 254–256, Plate **1**.

The type specimens themselves consist of (*a*) a fragment of the right maxilla, containing three molar teeth nearly complete, (*b*) an upper premolar with a fragment of the maxilla attached, in which is a second alveolus, and (*c*) an incisor or canine tooth. These were figured, as above mentioned, in 1845. Associated with the types by Gibbes, and contained in the lot of material now at hand, are (*d*) the left half of a mandible, nearly complete, but with the condyle missing, some of the teeth crushed and without crowns, and others lacking altogether; and (*e*) a small fragment from the right side of a mandible, to which is attached a canine or incisor tooth with a broken crown. These specimens were figured by Gibbes in a second article (Journal of the Academy Natural Sciences of Philadelphia, 1847, series 2, Vol. 1, pages 1–15, Plate **3**, figures 1–2).

In this latter article Gibbes figured (Plate **3**, figures 5–6) also another fragment which is in the collection, namely, (*f*) a portion of a left premaxilla. He also mentioned (*g*) a fragment of a right premaxilla which is present, and (*h*) figured (*op. cit.*, Plate **2**, figure 1, two views, unnumbered) an incisor or canine tooth, which has likewise been preserved.

In addition to the foregoing, the collection contains the following: — (*i*) The zygomatic process of the left squamosal, incomplete; (*j*) a portion of the right parietal; (*k*) the orbital plate of the right frontal, nearly complete; (*l*) the right and left nasals, nearly complete; (*m*) a portion of the petrosal?; (*n*) a portion of the right ramus of the mandible; (*o*) several fragments of teeth; (*p*) part of an atlas; and (*q*) portions of three ribs.

The history of the genus Dorudon has been summarized by Müller, Carus, Leidy, Hay, and others, and it will be unnecessary for me to do more in the present connection than refer to the principal views which have been held regarding it. A list of references will be found in Hay's Bibliography of Fossil Vertebrata of North America, 1902, page 587.

In the original description, in 1845, Gibbes mentioned that the type-specimen was found "in a bed of green sand near the Santee Canal, in South Carolina. The locality is on the plantation of R. W. Mazyck, Esq., about three miles from the entrance of the canal from the head waters of the Cooper River . . . I visited the locality where it was found, but the marling operations of the planters had ceased for the season, and the pits were filled with water. I have made arrangements for excavations in the fall, when I hope to procure other bones of this remarkable fossil" (Proceedings of the Academy of Natural Sciences of Philadelphia, 1845, Vol. 2, pages 254–255). In his second article Gibbes remarked: "During an extensive exploration of the bed of green sand at the locality [where the type was found], with the hope of turning up other portions of the skeleton, fragments of a lower maxilla containing the then unfigured tusk were procured, with twelve caudal vertebrae." (Journal of the Academy of National Sciences of Philadelphia, 1847, series 2, Vol. 1, page 10).

In this second article Gibbes, influenced by the opinion of Owen (Proceedings of the Academy of Natural Sciences of Philadelphia, 1846, Vol. 3, page 15), abandoned his genus Dorudon, placing the species *serratus* in the genus Zeuglodon, or Basilosaurus. In 1848 Agassiz (Proceedings of the Academy of Natural Sciences of Philadelphia, 1848, Vol. 4, page 4) expressed the belief that Dorudon was distinct, but the characters which he assigned to it are not intelligible. Leidy in 1869 (Journal of the Academy of Natural Sciences of Philadelphia, 1869, series 2, Vol. 7, page 428, Plate 29, figures 2–5) also accepted Dorudon, and gave a list of synonyms of *D. serratus*, among which are included *Zeuglodon brachyspondylus* Müller, and *Z. hydrarchus* Carus, both based on the same specimen. He remarks, however, that it is by no means certain that *serratus* and *brachyspondylus* are the same. In this connection Leidy published some figures of teeth from the Eocene of Alabama, which he regarded as belonging to Dorudon.

Cope in 1890 remarked: — "When the *Z. brachyspondylus* Müll. is better known it may be found to be referable to a distinct genus, Doryodon Gibbes" (American Naturalist, 1890, Vol. 24, page 602).

Dames in 1894 states that he cannot agree with Leidy in regarding *Zeuglodon brachyspondylus* as a synonym of *Dorudon serratus*, and affirms that the latter is easily distinguished from *Z. brachyspondylus* or *Z. macrospondylus* (= *Basilosaurus cetoides*) by the form of the teeth.[1] His remarks on this point are as follows: — "The straight, high, and pointed accessory cusps, which are very large as compared with the principal cusp, suffice to distinguish the tooth-crowns of *Dorudon serratus* from those of the Zeuglodons from Alabama; in addition, the roots, both branches of which are always nearly parallel in the latter, in Dorudon diverge at an angle of about 80° . . . Whether one proceeds more properly in keeping Zeuglodon and Dorudon separate as genera, or in treating *D. serratus* as a separate species of Zeuglodon, is uncertain. I should incline to the first course."

In the following pages I shall endeavor to explain my own view, which nearly coincides with that of Dames, and is that the genus Dorudon is distinct from Basilosaurus, and that the species which Müller mentioned as a small form of his *brachyspondylus*[2] is allied to the former but represents a distinct genus.

It is somewhat remarkable that Gibbes did not mention more than a part of the specimens which were sent me from the Museum of Comparative Zoölogy as belonging to the "Gibbes collection." One can only conjecture that he received some of them after the publication of his two articles, or that he did not recognize them as belonging to Dorudon. There is, indeed, no proof that they all represent that genus, but after examining them I am of the opinion that, with the possible exception of the ribs, they all belong to *Dorudon serratus*, and probably to the same individual. I base this opinion on the fact that they are all of one color and are all filled with a green sand of uniform texture and color, and that the size of the different parts appears to be properly proportional. In order to bring the evidence as regards size clearly before the reader, I have made a restoration of the skull, in outline, which is represented in figures 1 and 2, one-eighth natural size. The parts actually present in the Gibbes collection are indicated by heavy lines, and among them will be recognized those figured by Gibbes in 1845 and 1847. All these parts are represented in Plates **1**, **2**, and **3**, which are reproduced from photographs.

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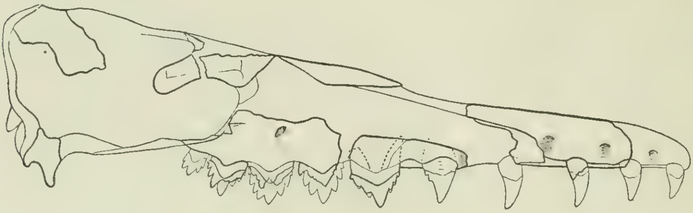
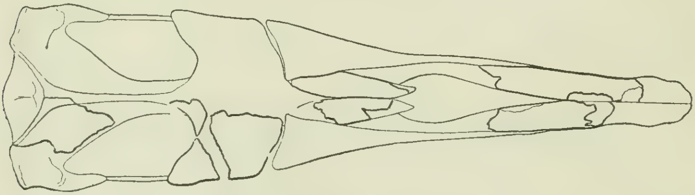
[1] Pal. Abh., 1894, (2), Bd. 1, Heft 5, p. 16. He also corrects the erroneous statement of Zittell (Handbuch Pal. Vert., 1893, p. 168) that Dorudon is based on vertebrae of *Z. brachyspondylus*.

[2] The confusion between the large form of zeuglodont with short lumbar vertebrae and the small form of zeuglodont with short lumbar vertebrae in Müller's work is very puzzling. The latter is sometimes referred to by him merely as *Z. brachyspondylus*, and sometimes as "der kleine Zeuglodon." He was in doubt as to this small form, as shown by his remark on p. 29: "Whether the small Zeuglodon is a separate species . . . or the young of *Zeuglodon brachyspondylus* is still uncertain at present."

In the appendix to his work (p. 31), however, he describes the small skull now in the Teyler Museum, Haarlem, as "a small individual of *Zeuglodon brachyspondylus*." This would be satisfactory if it were not that he also describes the large, short lumbar vertebrae on page 26 under the same name.

Recognizing this difficulty, Von Stromer in 1903 (Mitth. Pal. und Geol. Inst. Univ. Wien, 15, p. 85), limits the name *brachyspondylus* to the form represented by large, short lumbars, and assigns the name *brachyspondylus minor* to the small species with short lumbars. This nomenclature is accepted in the present paper.





Gibbes recognized the fragment of the maxilla containing three teeth to be such in 1845, but in 1847 he described and figured it, together with the premaxilla, as a part of the mandible. The right premaxilla contains the third incisor and a part of the alveolus of the second. The first incisor and the adjoining parts of the premaxilla are lacking, and are restored in figures 1 and 2. Both premaxillae show the large concavity in which the anterior end of the maxilla rests, but the nasal branch above it is broken off, and is restored in the figures. The length of the latter depends, of course, on the length of the anterior extension of the maxilla which articulates with the premaxilla. As this is lacking in part, the length of the nasal branch of the premaxilla is uncertain, as are also the exact proportions of this region of the skull.

The left nasal bone is nearly complete, and of the right about one-half remains. It is possible, therefore, to show quite exactly the shape and relative position of these bones. The outer margin is divided unsymmetrically into two parts, of which the posterior is the shorter. This shorter margin appears to articulate with the maxilla, and the longer margin with the premaxilla. The two nasals fit together accurately in the middle, the right one having a superior ledge which lies on an inferior ledge of the left nasal. The median line of junction is somewhat sinuous. The nasals in transverse section are strongly curved, and when joined together in the natural position, form a vaulted roof over the nasal cavity. At the posterior end the inferior surface is marked with coarse, longitudinal sutural ridges.

The detached fragment containing a single tooth, which Gibbes figured in 1847 in his Plate **4**, figure 4 (see Plate **1**, figure 4, accompanying this article), is very important and at the same time rather difficult to interpret. Accompanying the fragment is another of similar size which fits against the root of the tooth and contains the alveolus of a second tooth. After closely studying the tooth which is present, I am of the opinion that the other alveolus belongs in front of it and is that of the first premolar. Anterior to this alveolus is a small, conical piece of bone, which represents the anterior end of the maxilla, so far as it is preserved, but how much is lacking is uncertain, as is also the position of the canine, of which no trace remains. That there was another premolar tooth anterior to the alveolus above mentioned is improbable. That the fragment containing the tooth is from the anterior part of the maxilla, and that the tooth is, therefore, a premolar, is evident from the fact that its external surface is nearly flat, while in the fragment with three teeth, presently to be mentioned (which bears the articulation for the malar at the posterior end and is therefore the posterior part of the maxilla), the external surface is quite convex. The anterior and posterior margins of the crown of the premolar tooth are, I believe, distinguishable, owing to the fact that in all the teeth of Zeuglodon and its allies, as shown by specimens in the National Museum and by the figures of Müller, Andrews, and other authors, the accessory cusps are smaller and further from the apex of the tooth on the anterior margin than on the posterior.

The inferior surface of the maxillary fragment containing PM² and the alveolus of PM¹, just mentioned, is apparently complete, and indicates that the palate, and hence the rostrum also, was quite narrow behind the canines, although the posterior extension of the palatal branch of the premaxillae may have added a little to the breadth. This fragment is from the left side, while the piece of the maxilla containing three teeth is from the right side. Hence, it is not possible to determine positively whether, when the former is transposed to the right side, as has been done in figure 1, the two pieces should be contiguous, or whether space for another tooth should be left between them. I am of the opinion that they should be contiguous.

The fragment containing three teeth (Plate **1**, figure 2) is one of Gibbes's types and was well figured by him in 1845 (Proceedings of the Academy of Natural Sciences of Philadelphia, 1845, Vol. 2, Plate **1**, figure 4) and 1847 (Journal of the Academy of Natural Sciences of Philadelphia, 1847, series 2, Vol. 1, Plate **4**, figure 1), though reversed, and in 1847, at least, considered as belonging to the mandible. Beside the three teeth it has, at the posterior end, a concavity which represents the outer wall of the alveolus of a tooth about half the size of the others. This was probably the last molar (M^2). The three large teeth are all somewhat broken, but enough of them remains to indicate their original form and size. A very small fragment of the palatal surface of the maxilla remains attached to the second of these teeth near its anterior root. It is concave and presents a small depression which may mark the position of the apex of one of the mandibular teeth. As already mentioned, the fragment bears at the posterior end a short, triangular process, flat on top, intended to receive the anterior end of the malar bone. A small piece only appears to be lacking from the process. The outer surface of the maxilla above the three large teeth is convex, and there is a depression above the second tooth (PM^4) which appears to represent the anteorbital foramen. Above the third tooth (M^1) a short, narrow, triangular ridge is developed. This ridge appears to be nearly complete, and its free end is probably about in line with the posterior margin of the maxilla, or, in other words, the anterior margin of the orbit. The shape of the maxilla above the three large teeth (PM^3, PM^4, and M^1) and of the ridge just mentioned is characteristic of Dorudon, and distinguishes it from *Zeuglodon brachyspondylus*, but Prozeuglodon appears to have a similar conformation.

The original height of this posterior portion of the maxilla cannot be determined accurately, but from the small angle between the superior and inferior surfaces of the premaxillae and the rather small orbit, one may infer that it was not great.

The frontal is represented only by the right orbital plate (Plate 2, figure 2), which is in three pieces. These pieces cannot be fitted together, but the shape of the arch of the orbit indicates that the outer free margin is complete, or nearly so. Anterior to the orbit is a triangular prolongation, on a slightly lower level than the top of the orbit itself, and having the surface somewhat different in texture. It is possible that this triangular area was overlapped by the posterior thin end of the maxilla.

Behind the frontal no part of the upper surface of the skull is preserved, except a portion of the right parietal bone (Plate 2, figure 3). This, fortunately, is complete in the median line and posteriorly, and indicates the form of the occipital and sagittal crests. The distance between the vertex and the nasals can, however, only be estimated.

A small piece of the squamosal (Plate 2 figure 4) from the left side indicates the shape of the zygomatic process and the position of the external auditory meatus. The occipital condyles are lacking, and nothing can be determined regarding the inferior surface of the skull except as above mentioned.

The teeth merit a special description. As already stated, the first upper incisor is lacking on both sides, the premaxillae being incomplete anteriorly. A portion of the alveolus of the second upper incisor is present on the left side. When complete, it measured about 22 mm. in diameter longitudinally. The distance between it and the alveolus of the third incisor is 29 mm. The longitudinal diameter of the latter alveolus is 25 mm., and of the third incisor itself, measured on a level with the top of the alveolus, 21 mm. The transverse diameter of the tooth at the same point is 15 mm. As indicated by these measurements, the root of the tooth is elliptical in section at its junction with the crown. Only a small portion of the latter remains, but sufficient to show that the enamel was strongly rugose, and that a well-defined, narrow ridge extended from the base of the crown probably to the apex posteriorly.

The alveoli of the upper incisors are connected by a narrow groove. The palatal surface of each premaxilla internal to this groove is flat, and is divided longitudinally in the centre by another groove, running parallel with the median border. In front of and behind the third incisor the outer surface of the premaxilla is strongly compressed. In front of the tooth, at a height of about 22 mm. above the palatal surface, is a circular concavity, representing the position of the apex of the lower third incisor when the mouth was shut. A similar concavity behind the tooth, about 28 mm. above the palatal surface, indicates the position of the apex of the lower canine. That it is higher up than the preceding concavity shows that the canine is longer than the third incisor in this species.

Following the third upper incisor, there is a deep concavity in the premaxilla, in which the anterior end of the maxilla rested. The latter bone is broken anteriorly, and hence nothing can be determined regarding the form, or exact position, of the canine. The most anterior portion of the maxilla preserved contains, as already mentioned, the alveolus of a large tooth, which was presumably the first upper premolar, and following it a still larger tooth in its socket which I consider the second premolar. The alveolus of the first premolar is pyriform, and has a longitudinal diameter of 39 mm. and a transverse diameter of 21 mm. Immediately in front of it, where the bone is broken off, is a concavity not less than 18 mm. deep, and inclined inward and backward, which I was at first disposed to regard as the anterior root of the first premolar. After close examination I am of the opinion that it represents the impression of the apex of the first lower premolar. The bottom of it lies a little outside the line of the long axis of the large alveolus which succeeds it.

The first upper premolar was probably a single-rooted tooth, as the alveolar cavity narrows rapidly upward. The distance between this tooth and the second upper premolar is 16 mm. In the interval between the two teeth and a little within the line of the long axis of the former is a rather shallow concavity, which represents the impression of the apex of the second lower premolar.

The second upper premolar of the left side, a two-rooted tooth, has the following dimensions (Plate 1, figure 4): Depth from apex of crown to end of anterior root,[1] 71 mm.; to end of posterior root,[1] 71; breadth of crown at base, 52; length of anterior edge of principal cusp, 22; length of posterior edge of the same, 19; antero-posterior breadth of the anterior root, on the line of anterior base of the crown, 20; antero-posterior breadth of posterior root, on line of posterior base of crown, 25; transverse breadth of the anterior root at the same point, 14; transverse breadth of the posterior root at the same point, 15; distance between the apex of the principal cusp and the point of junction of the two roots, 34.

The greatest height of the enamel at the middle of the crown as preserved is 27 mm., but there are sundry dark spots and rough points on the roots which appear to indicate that the crown was originally somewhat deeper, perhaps as much as 40 mm. all together at the middle on the inner face and 36 mm. on the outer face. This would change the shape of the crown materially and bring it much nearer the margin of the maxillary bones than is indicated in Plate 1, figures 2 and 4. However it may be with this premolar, the crown of the molars is certainly much less deep than in Basilosaurus.

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[1] Slightly broken.

The second premolar has three accessory cusps both anteriorly and posteriorly, the former smaller than the latter and further removed from the apex of the principal cusp. The free border of the anterior cusp adjoining the basal one bears a thin, sharp ridge, which is also apparent on the cusp next above. The anterior and posterior edges of the principal cusp are sharp, the former most so. The internal and external surfaces of the crown are convex, and the enamel, although everywhere somewhat rugose vertically, is conspicuously so only on the internal surface near the base of the crown. The roots are hollow, as mentioned by Gibbes.

Whether the three teeth (Plate 1, figure 2) which form part of Gibbes's types immediately follow the premolar tooth just described cannot be positively determined, but it is probable that they do; and they are, therefore, the third and fourth premolars and the first molar.

The third premolar is a somewhat smaller tooth than the second, with the two roots less divergent. The crown is badly broken, only the penultimate posterior accessory cusp remaining intact. Nearly all of the internal half of the tooth is lacking, but its shape is indicated by the green sand with which it was filled. The length of the posterior root from its junction with the anterior root is 43 mm., but was originally somewhat longer. The antero-posterior breadth of the crown is about 49 mm., and of the anterior root at its junction with the crown, 17 mm. The transverse diameter of the root at the same point was originally about 12 mm. The distance from the margin of the maxilla to the crown at the middle is 11 mm. The small portion of the enamel which remains is nearly smooth. The free margin of the penultimate posterior accessory cusp bears a sharp, thin ridge.

The fourth premolar follows the third with scarcely more than one or two millimeters intervening. Its anterior root, however, is a little external to the posterior root of the third premolar, and the form of the tooth is quite different. The anterior root at its junction with the crown has an antero-posterior diameter of 21 mm. and a transverse diameter (maximum) of 11 mm., while the posterior root has the same antero-posterior diameter but a transverse diameter of 21 mm. The posterior root is, therefore, about twice as thick as the anterior one, and extends much further inward on the palate than the anterior one. It stands somewhat obliquely, as does also the part of the crown which surmounts it. Whether this posterior root is really divided so that the tooth has three roots in all cannot be positively determined from the specimen, which is filled with plaster at this point, but as the root measures 24 mm. at the end, it is quite likely that it is divided. Owing to the oblique position of the posterior root, the crown is somewhat triangular in horizontal section; the greater part of it, including all the cusps except the very small anterior basal one, is lacking. The antero-posterior length of the crown at the base is 48 mm.; the vertical length of the anterior root is 41 mm.

The first molar immediately follows the fourth premolar and is a somewhat smaller tooth. It is two-rooted, though the posterior root is somewhat twisted and thickened, and a horizontal section of the crown at the base shows a postero-internal enlargement, which gives it somewhat of a triangular form. The antero-posterior breadth of the crown at its base is 41 mm., and its greatest transverse diameter posteriorly, 15 mm. The middle portion of the crown is lacking, but the accessory cusps are nearly intact. These are of about the same size and shape as those of the first premolar, being convex both externally and internally and nearly vertical. There appear to have been two large anterior accessory cusps and a smaller basal one, and three posterior accessory cusps, together with a very small basal one, which probably represents part of the cingulum. The enamel is nearly smooth externally and only moderately rugose, with longitudinal lines, internally. At the middle of the tooth externally the distance between the base of the enamel and the margin of the maxilla is 12 mm., but internally the enamel extends farther up.

The concavity which follows the first molar and appears to represent the alveolus of the second molar is 26 mm. long. As it is undivided, this small tooth probably had the roots consolidated. It is not likely that any additional teeth followed this one.

The mandible which is included in this collection is so much broken that no detailed description of it seems desirable. The left side is represented by a piece 430 mm. long, extending from the second or third incisor to and somewhat beyond the posterior end of the tooth-row. The right side is represented only by fragments from the lower margin of the ramus and a very small part of the symphysis (Plate 2, figure 6), with a canine, or incisor, tooth in position. This latter piece was figured in 1847 by Gibbes in his Plate 3, figure 2. Nearly all of it, however, has been lost since that date, and the tooth has been detached but is still preserved.

The left side of the mandible (Plate 3, figure 1) was also figured by Gibbes in 1847 in his Plate 3, figure 1. All the parts there shown are preserved, except the portion of a crown of a tooth which appears near the left-hand end of the figure. This figure is one-half natural size. Whether this mandible belongs to the same individual as the cranial fragments is uncertain, but if the proportions of the restoration are correct, it was about 680 mm. long when complete, or about one-half longer than at present. The first two-rooted tooth, or premolar, appears to be the one of which a portion of the crown is shown in Gibbes's figure. This is situated 104 mm. behind the anterior end of the jaw. In front of it, at the anterior end, are a portion of a simple alveolus, which should be that of the second incisor, and two other simple alveoli about 24 mm. in diameter, which should represent the canine and third incisor. These are 15 mm. apart, and the latter is 15 mm. from the first premolar. The latter tooth is succeeded by the second premolar, apparently without an interval. The upper end of the roots of the tooth measures 39 mm. antero-posteriorly. The location and number of teeth posterior to the second premolar cannot be determined from the specimen.

The symphysis is about 152 mm. long, as indicated by the flat internal surface of the left side of the jaw, and was probably but little prolonged anteriorly when complete. It ends posteriorly about opposite the second premolar, as in Prozeuglodon.

Of the atlas which accompanies the skull-fragments, little more than the lower half remains (Plate 2, figure 13). It is comparatively slender. The anterior articular facets are strongly declined. They are separated from the posterior facets by a ridge. The posterior facets are oblique rather than vertical. The inferior lateral process (broken) is thick at the base and compressed. It is only moderately directed downward and backward. The vertebrarterial foramen is large and is in line with the outer margin of the anterior articular facet. The following measurements were taken from the fragment: — Breadth between outer margins of anterior articular facets, 104 mm.; greatest thickness of atlas, 33; least thickness in median line, 24; breadth of inferior transverse process at base, 25.

The teeth figured by Gibbes in 1847 in Plate 2, figure 1 (two views), and Plate 4, figure 3 (two views), are both in the collection (Plate 2, figures 7 and 8). The peculiar form of the crown of the former tooth is due to the fact that the upper half has been restored in wax and not properly shaped. The enamel is much rougher at the base than is indicated in Gibbes's figure. The other tooth is at present much broken. All the teeth, as Gibbes remarked, are hollow and filled with green sand.

None of the caudal vertebrae mentioned by Gibbes accompanied the other bones. The small ones figured by him in 1847 in his Plate 2, figures 4 and 5, might belong to the present species, but they are from too near the end of the tail to present any very strongly marked characters. They give a little support to the view that *Dorudon serratus* is a form with relatively short vertebrae like *Z. brachyspondylus minor*, instead of long vertebrae like *B. cetoides*.

For the comparison of Dorudon with other American zeuglodonts, I have had the use of the nearly complete skeletons of *Basilosaurus cetoides* and *Z. brachyspondylus minor*, collected by Professor Charles Schuchert in Alabama, and now in the National Museum, and a cast of the type skull of *Z. brachyspondylus minor* Stromer,[1] in Teyler's Museum, in Haarlem, which was sent to the National Museum for my use by the director, Professor E. Dubois.

The large species *B. cetoides* (or *macrospondylus*) is, I think, sufficiently differentiated from the others by its excessively elongated lumbar vertebrae and extremely thick epiphyses to be regarded as the representative of a separate genus. Its scientific name is properly *Basilosaurus cetoides* (Owen). Several Old World species have been associated with it under the synonymic generic name Zeuglodon, but *Z. isis* Andrews is the only one, apparently, which has elongated vertebrae. The dental formula of Basilosaurus was not given by Müller, and cannot be worked out fully from the material in the National Museum. The formula for the lower jaw, however, appears to be C. 3, I. 1, PM. 4, M. 3. The formula given by Andrews for Zeuglodon is, i. $\frac{3}{3}$; c. $\frac{1}{1}$; pm. $\frac{4}{4}$; m $\frac{2 \text{ or } 3}{3}$,[2] but as this is based on, or at least includes, species with short lumbar vertebrae, it cannot be considered as necessarily correct for Basilosaurus, though the difference, if any, will doubtless prove slight when the dentition of the latter becomes fully known.

In *Basilosaurus cetoides* the atlas is thick and the posterior articular surface vertical. The anterior and posterior articular facets are separated from each other by a very broad, flat surface. The vertebrarterial canal is not sunk into the side of the vertebra, but is about in line with the outer edges of the articular facets. The inferior lateral process is not strongly inclined backward. The upper surface of the premaxillae is flat, but the nasal branch strongly bent upward. The first upper premolar is small.

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[1] "Der Kleine Zeuglodon" of Müller.

[2] A descriptive catalogue of the Tertiary Vertebrata of the Fayûm, Egypt. 1906, p. 236.

On comparing the type of *Dorudon serratus* Gibbes, with the type of *Zeuglodon brachyspondylus minor*, and the small zeuglodont from Alabama in the National Museum, I find that the Alabama specimen agrees with *Z. brachyspondylus minor*, and without doubt represents that form. *Dorudon serratus*, on the other hand, although of the same size, presents numerous differences. These are best seen in the following parallel columns:

Dorudon serratus.	*Zeuglodon brachyspondylus minor.*
1. Incisors smaller.	1. Incisors larger.
2. Incisors differently spaced from those of *Z. b. m.*	2. Incisors differently spaced from those of *D. s.*
3. Nasals vaulted.	3. Nasals flat.
4. Premaxillae broad and convex on top.	4. Premaxillae rather narrow and flat on top.
5. Premaxillae deep and flat on the sides.	5. Premaxillae not so deep, and convex on the sides.
6. Proximal end of nasal branch of premaxillae not strongly bent up.	6. Proximal end of nasal branch of premaxillae strongly bent up.
7. Atlas comparatively thin.	7. Atlas thick.
8. Outer expanded portion of posterior articular facets of atlas oblique.	8. Outer expanded portion of posterior articular facets of atlas vertical.
9. Vertebrarterial canals nearly in line with outer ends of articular facets.	9. Vertebrarterial canal much within the line of the articular facets.
10. Anterior and posterior articular facets of atlas separated above by a narrow flat surface.	10. Anterior and posterior articular facets of atlas separated above by a broad concave surface.
11. Inferior lateral process of atlas but little inclined backward.	11. Inferior lateral process of atlas much inclined backward.

Although some of the foregoing characters are doubtless to be regarded as specific, I think that, taken together, they afford sufficient warrant for maintaining Dorudon as a separate genus, at least until more material representing *D. serratus* has been collected. As *Basilosaurus cetoides* is also, I think, to be considered distinct, on account of its excessively long lumbar vertebrae and very thick epiphyses, the form *brachyspondylus minor* appears to require a new generic appellation. I would propose the name ZYGORHIZA, and would assign to the genus the characters given in the foregoing column, under *Z. brachyspondylus minor.* This subspecies is the type of the genus.

The upper molars of *Z. brachyspondylus minor* are smaller than those of *D. serratus*, the anteorbital region is differently shaped, and the occipital crest is much higher. The last-mentioned character may, however, be due to difference in age or sex.

The dental formula of *Z. brachyspondylus minor* cannot be positively determined from the material at hand. For the lower jaw, however, it appears to be I. 3, C. 1, PM. 4, M. 3. The number of teeth is less important among the zeuglodonts than their form, as the difference in the various genera is not more than one molar tooth above and below. The divergence of the roots of the premolar and molar teeth, which is mentioned by Dames as a distinguishing character of Dorudon, appears to me of no great value, as the roots of the lower premolars of *Z. brachyspondylus,* at least, show a considerable divergence. The size and shape of the accessory cusps of the molars and premolars of *D. serratus* are not very different from those of *Z. brachyspondylus.* In Gibbes's figures of Dorudon, they are too nearly erect and somewhat exaggerated in size.

PLATE **1**.

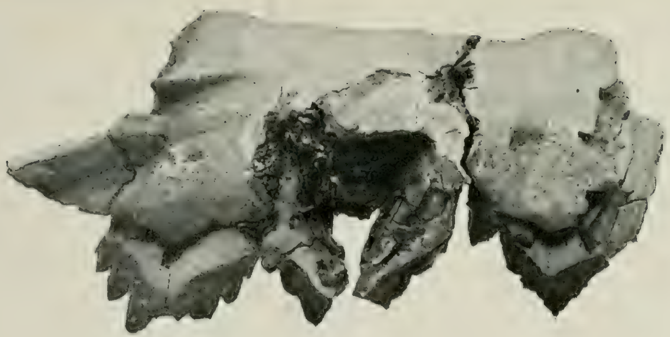
Dorudon serratus GIBBES.

FIG. 1. Portion of right premaxilla, showing alveolus of third upper incisor. Lateral aspect.

FIG. 2. Portion of right maxilla, with third and fourth upper premolars and first molar (broken). Lateral aspect. (Gibbes, 1847, Plate **4**, figure 1.)

FIG. 3. Portion of left premaxilla, with third upper incisor (broken); and showing impressions of third lower incisor and canine, and excavation for anterior end of maxilla. Lateral aspect. (Gibbes, 1847, Plate **3**, figures 5–6.)

FIG. 4. Portion of left maxilla, with second upper premolar, and alveolus of first premolar. Lateral aspect. (Gibbes, 1847, Plate **4**, figures 2 and 4.)



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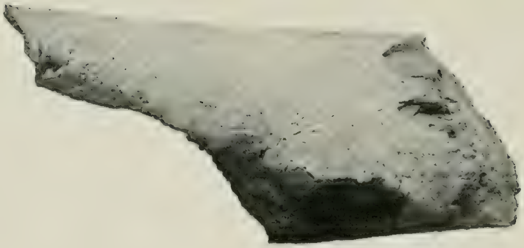

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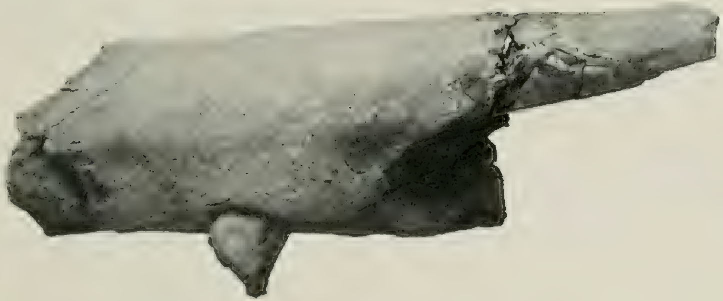

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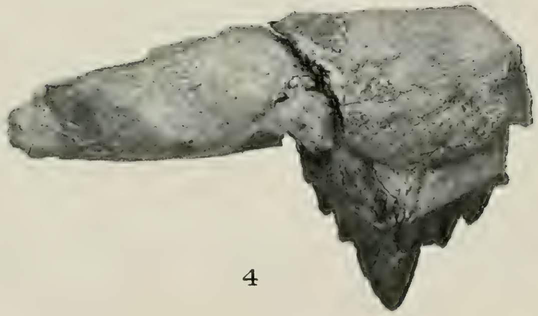

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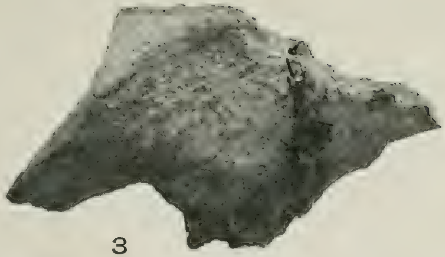
PLATE 2.

Dorudon serratus GIBBES.

FIG. 1. Nasals. Superior aspect.
FIG. 2. Orbital plate of right frontal (three pieces). Superior aspect.
FIG. 3. Portion of right parietal, showing occipital and sagittal crests. Superior aspect.
FIG. 4. Portion of left zygomatic process. Lateral aspect.
FIG. 5. Portion of periotic ?
FIG. 6. Right lower canine, or incisor, with fragment of mandible. Lateral aspect. (Gibbes, 1847, Plate **3**, figure 2.)
FIGS. 7–12. Teeth more or less broken. The crown of figure 7 has been restored incorrectly. (Figure 7 = Gibbes, 1847, Plate **2**, figure 1. Figure 8 = Gibbes, Plate **4**, figure 3.)
FIG. 13. Atlas. Anterior aspect.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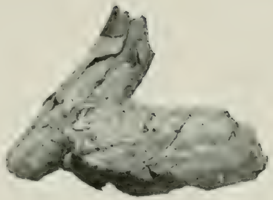
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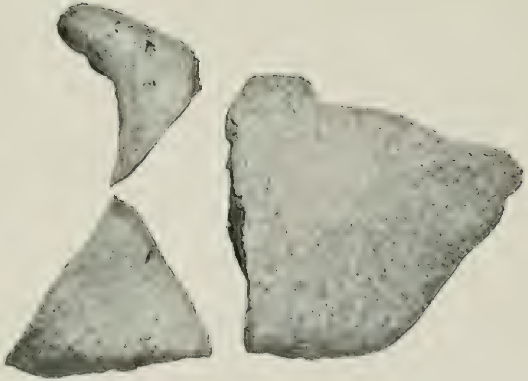
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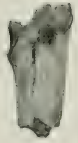
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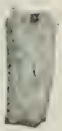
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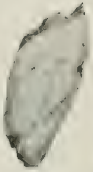
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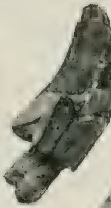
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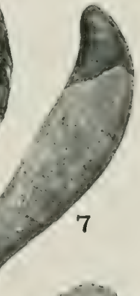
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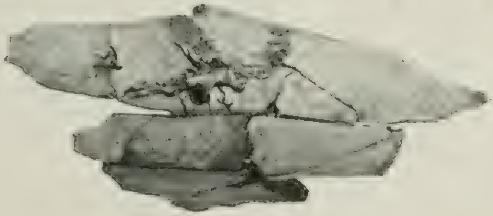
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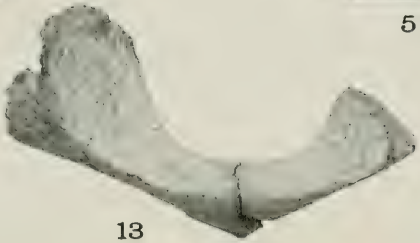
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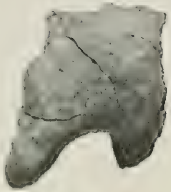
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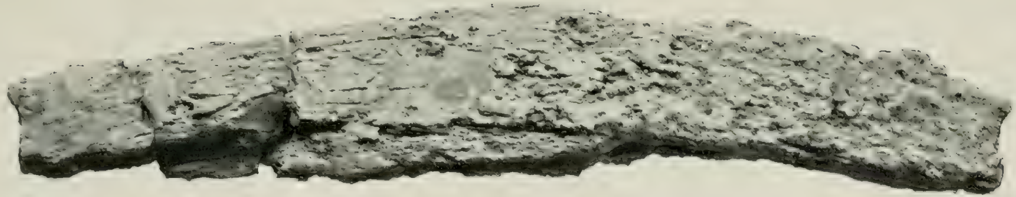
PLATE 3.

Dorudon serratus GIBBES.

FIG. 1. Left half of mandible (broken at both ends). Lateral aspect. (Gibbes, 1847, Plate 3, figure 1.)

FIG. 2. Portion of right ramus of mandible.

FIGS. 3–5. Ribs.



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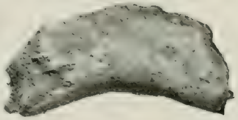

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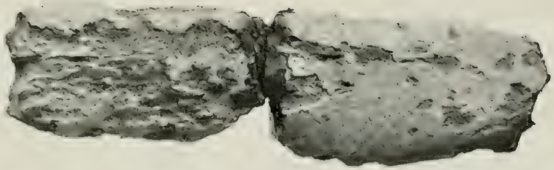

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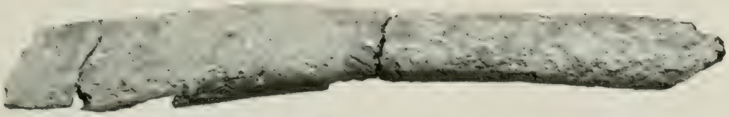

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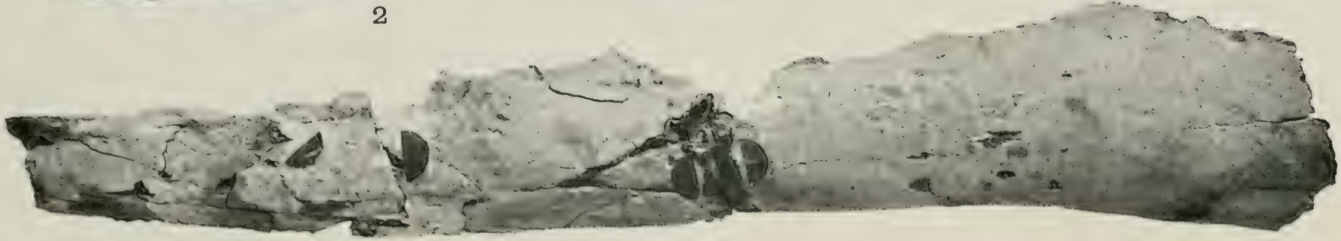

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REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XV.

UEBER DIE ANATOMIE UND SYSTEMATISCHE STELLUNG VON BATHYSCIADIUM, LEPETELLA, UND ADDISONIA.

VON JOHANN THIELE.

WITH TWO PLATES.

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XV.

Ueber die Anatomie und systematische Stellung von Bathysciadium, Lepetella, und Addisonia.

Von JOHANN THIELE.

PELSENEER hat die Anatomie des sehr kleinen *Bathysciadium conicum* Dautzenberg & H. Fischer=*costulatum* (Locard) untersucht und dar über folgende Angaben gemacht (Bull. Soc. Zool. France, v. 24, p. 209).

Der Kopf trägt 2 Tentakel ohne Augen und rechts einen langen, am Ende zugespitzten und rückwärts gebogenen Fortsatz. Der Fuss hat in der Mitte eine rundliche Erhebung, deren Epithel eine starke Cuticula ohne Cilien aufweist. Kiemen fehlen. Das Nervensystem lässt von einander entfernte Cerebralganglien und lange Stränge im Fuss erkennen. Jede der beiden Otocysten enthält einen kugelrunden Otolithen. Im Munde liegt vorn ein kleiner unpaariger Kiefer. Die sehr lange Radula hat in jeder Querreihe 10 Zähne, demnach fehlt der Mittelzahn. Der Magen ist sehr geräumig, der Darm kurz, er mündet über dem Kopfe zwischen den Nieren aus. Das Herz liegt im vordern Teil der linken Seite. Die beiden Nieren liegen über dem Nacken, die linke ist grösser als bei Patelliden, doch übertrifft die rechte sie an Länge. Die zwittrige Keimdrüse nimmt den ganzen dorsalen Teil der Eingeweidemasse ein. Der männliche Anteil ist links gelegen. Eine besondere Genitalöffnung ist nicht vorhanden, wahrscheinlich fallen die Keimstoffe in die rechte Niere. Der rechtsseitige Kopfanhang ist vermutlich zur Copulation bestimmt, ventral hat er eine Längsrinne.

Aus seinen Befunden schliesst Pelseneer, dass die Gattung sicher zu den Patelliden gehört (2 Nieren, Herz mit Vorhof, Fussnervenstränge, lange Radula und kegelförmige Eingeweidemasse), doch unterscheidet sie sich von den andern durch ihren Hermaphroditismus, den einzigen Otolithen und die Form der Radulazähne. Daher lässt sie sich keiner der 3 Familien der Docoglossen einreihen und es ist die Schaffung einer besonderen Familie erforderlich.

Von Herrn Prof. Vayssière habe ich ein Tier derselben Art erhalten, das aber leider beschädigt war, und infolgedessen habe ich nur die Radula davon präparirt. Da mein Befund nicht ganz mit Pelseneers Darstellung übereinstimmt, sei darüber Folgendes bemerkt. Eine Mittelplatte ist vorhanden, wenn auch dünn, so doch von beträchtlicher Grösse, breiter als lang mit wenig gebogenem Vorderrande, der an den Seiten kleine Buchten aufweist (Fig. 7a); der hintere Teil ist undeutlich. Jederseits davon liegen 3 Zwischenplatten (Fig. 7b), die innerste ist vorn schmal, abgerundet, ohne Schneide, hinten mit einer rundlichen Verbreiterung; die folgende Platte liegt meist versteckt unter der grossen benachbarten, sie hat die in Fig. 7c dargestellte Form, vorn schmal, mit einer schwachen Andeutung einer Schneide, hinten stark verbreitert. Die äusserste Zwischenplatte (Fig. 7b) ist am stärksten entwickelt, mit einer deutlichen, etwas zugespitzten Schneide, hinten gerade; durch eine Furche ist der hintere Teil vom vordern getrennt und Pelseneer scheint beide für besondere Zähne gehalten und die Radula von der Unterseite angesehn zu haben. Die Seitenplatte endlich (Fig. 7d) schiebt sich mit ihrem mittleren Teil unter die Aussenecke der äusseren Zwischenplatte; in der Mitte hat sie 2 hinten vorspringende Verdickungen.

Durch die grosse Güte des Herrn Dr. Dall bin ich nun in die Lage versetzt, das einzige Tier des bedeutend grösseren *Bathysciadium pacificum* untersuchen zu können; ich habe es in eine Folge von Querschnitten zerlegt und daran die Hauptsachen der Anatomie festzustellen versucht. Einige Verhältnisse waren trotz der im ganzen genügenden Conservirung nicht mit Sicherheit festzustellen, so hauptsächlich der Verlauf der Visceralcommissur.

Äusserlich ist das Tier ähnlich dem von *Bathysciadium costulatum*, wie es Pelseneer abgebildet hat, der Kopf ist verhältnissmässig gross mit einem kurzen und breiten Schnauzenteil und jederseits einem kurzen Tentakel, hinter dem rechten mit einem ziemlich grossen, rückwärts gerichteten Copulationsorgan (Fig. 1). Der Fuss wird von der Schnauze durch einen breiten Zwischenraum getrennt, er ist breiter als lang, vorn etwas ausgebuchtet, in der Mitte der Sohle mit einem rundlichen Vorsprung. Der Mantelrand zeigt Falten, welche die Radiärrippen der Schale erzeugen, an den Seiten bedeutend grösser als vorn und hinten. Einen wichtigen Unterschied von der genannten Art finde ich darin, dass

Bathysciadium pacificum eine grosse, im Nacken befestigte und nach rechts gewendete Kieme besitzt (Fig. 2, b). Der hufeisenförmige Schalenmuskel ist schwach, nur an den etwas der Mitte genäherten Vorderenden verstärkt.

Die Nackenhöhle, in der die Kieme entspringt, ist flach. Aus den Schnitten ist zu ersehn, dass die Kieme ein dünnes, vielfach gefaltetes Blatt darstellt (Fig. 12, b), sie ist demnach von derjenigen der Acmaeiden, die jederseits eine Reihe von Blättchen trägt, ganz verschieden.

Der Mantelrand ist mit einem hohen Epithel bekleidet, das nicht sensibel zu sein scheint, auch fehlen ihm Tentakel und andere Sinnesorgane. In die Faltungen des Mantels verlaufen Abzweigungen des Ringgefässes.

Zwischen Mantel und Fuss verläuft jederseits ein drüsiger Epithelstreifen (Fig. 15, gl), der sich nach hinten hin wulstförmig erhebt. Die Seitenteile der Fusssohle tragen ein Flimmerepithel, unter welchem mehr oder weniger zahlreiche Drüsenzellen liegen. Der vorgewölbte Teil der Sohle ist dagegen unbewimpert.

Augen sind nicht vorhanden. Die Otocysten, welche der Pedalcommissur anliegen, enthalten je einen kugelrunden Otolithen.

Vom Nervensystem kann ich nur angeben, dass die Cerebralganglien am Grunde der Tentakel liegen und durch eine vor dem Kiefer verlaufende Commissur zusammenhängen; die Buccalganglien liegen im vordern Teil des Kopfes mehr dorsal. Die Pleuralganglien sind mit dem vordern Teil der pedalen in Berührung; ich finde nur eine Pedalcommissur zwischen den vordern angeschwollenen Teilen der Ganglien, von denen nach hinten jederseits ein Nervenstrang abgeht, worin wenig Ganglienzellen enthalten sind. Der vordere Teil der Pedalganglien liegt auf der Fussmuskulatur in der Leibeshöhle, während die hinteren Stränge von einer Muskelschicht bedeckt werden. Über den Verlauf der Visceralcommissur bin ich im Unklaren geblieben.

In den Seitenteilen des Körpers verlaufen Muskelzüge in verschiedenen Richtungen, teils zum Fuss herab, teils in schräger oder in Längsrichtung; über dem mittleren Teil der Sohle ist eine sehr dünne Muskelschicht vorhanden, daher wird dieser Teil durch die über ihm gelegenen Eingeweide, besonders den vollgestopften Magen vorgewölbt.

An den Verdauungsorganen fällt der sehr grosse, aber einfache Schlundkopf auf, durch den auch die Grösse des Kopfes bedingt wird. Vor der grossen Mundöffnung findet sich ein kleiner, von einer einfachen Conchinlamelle gebildeter Kiefer (Fig. 12, mx). Jederseits von der Mitte ist ein grosser, ziemlich dünner, aber breiter, mit der oberen Hälfte seitwärts gebogener Knorpel (Fig. 12, kn) vorhanden, der aus sehr grossen Zellen gebildet wird; accessorische Stücke fehlen. Eine kräftige Muskulatur dient zur Bewegung dieser Knorpel.

Ein vollständiges Bild von der Radula ist aus den Schnitten nicht zu entnehmen, doch sind die Platten denen von *Bathysciadium costulatum* ähnlich. Der mittlere Teil wird von einer spitz vorspringenden Falte erhoben, so dass die Radula 2 Rinnen bildet, in deren Grunde die grossen äusseren Zwischenplatten liegen. Eine Seitenplatte habe ich in Fig. 14 dargestellt.

Von Speicheldrüsen ist nichts wahrzunehmen. Der Vorderdarm hat eine drüsige Erweiterung, die von zahllosen kleineren und grösseren Tröpfchen eines stark glänzenden braunen Sekretes erfüllt wird. Den weiteren Verlauf des Vorderdarmes zu verfolgen ist mir unmöglich, und trotz aller Mühe konnte ich nicht mit Sicherheit feststellen, wo die Leber in den Magen mündet. Dieser ist sehr umfangreich und wird von abgeraspelten Fetzen eines nicht näher erkennbaren Stoffes (Holz.?) prall erfüllt. Hinten wird er durch eine schräge Falte in 2 Abschnitte geteilt, deren linker weiter nach hinten reicht als der rechte. Aus der unteren rechten Ecke des linken Abschnittes entspringt eine Röhre, die ich eine Strecke weit nach vorn verfolgen kann, doch schliesslich ist nicht möglich festzustellen, wie sie endet, ich vermute indessen, dass sie das hintere Ende des Vorderdarmes darstellt. Die Leber umgiebt die Magenwände und enthält ganz ähnliche Körnchen wie die Vorderdarmdrüse; sie scheint in den vorderen Teil des Magens von der Unterseite einzumünden. Der Darm entspringt aus der linken Ecke des rechten Magenteils, zieht nach vorn, biegt unter dem Magen nach hinten um, und bildet eine ganz unter dem Magen gelegene hintere Schleife; deren anderer Schenkel (Fig. 15, i) verläuft nach vorn über den Magen hinaus und steigt zur Dorsalwand des Kopfes empor, um hier eine etwas complicirte Schleife zu bilden, die bis zum Vorderteil des Kopfes reicht, und dann unter der dorsalen Leibeswand nach hinten zu ziehn. Dieser Teil ist ganz mit solchen Körnchen erfüllt, wie sie die Leber erzeugt, während der übrige Teil des Darmes leer ist. Dieser mit Körnchen erfüllte Abschnitt (Fig. 15, i,) mündet in den Enddarm (ir), der ein höchst eigentümliches Aussehn hat, indem er stark gefaltete, drüsige Wände besitzt, so dass ich ihn zuerst für irgend eine Drüse hielt, bis ich den Zusammenhang mit dem Darm auffand. Die äussere Mündung findet sich in der rechten Hälfte der Mantelhöhle zwischen Nieren- und Keimdrüsenöffnung.

Es ist nur *eine* Niere vorhanden, sie liegt links vom Enddarm (Fig. 15, n), weiter hinter über seinem linken Teil, rechts von dem hintern, proximalen Teil der Kieme und vom Pericardium unter der dorsalen Körperwand. Sie ist ein ziemlich enger und langgestreckter Hohlraum mit einem kubischen, ungefalteten Epithel. Ganz in der linken Körperseite liegt das Pericardium (Fig. 15, p) mit dem Herzen (c); es hängt durch einen kurzen Gang mit dem vordern Teil der Niere zusammen. Diese zieht sich mit ihrem Vorderende vor und unter dem Enddarm herab und mündet nach unten in den rechten Teil der Mantelhöhle mit einem sehr engen und kurzen Gang aus.

Die Keimdrüse enthält männliche und weibliche Elemente, sie liegt über dem Darmtrakt und der Leber (Fig. 15, ov) und reicht hinten bis über den Magen hinaus, sodass sie den hintersten Teil der Eingeweide allein einnimmt. Männliche und weibliche Keimstoffe sind zwar nicht scharf gesondert, doch nehmen diese mehr die Mitte, jene mehr den Rand der Drüse ein. Durch einen nicht sehr langen, aber ziemlich weiten Ausführungsgang (Fig. 15, gd) gelangen die reifen Keimstoffe in den rechten Teil der Mantelhöhle, der kurze, enge, nicht drüsige Endteil des Ganges ist nach links gewendet. Hinter den Mündungen des Enddarms und Ausführungsganges zieht sich die Mantelhöhle zu einem Gang zusammen (Fig. 15, rec), der unter und weiter hinten rechts vom Ausführungsgang der Keimdrüse verläuft, hinter dem Ende dieses Ganges nach links umbiegt und mit einem weiten sackartigen Hohlraum unter der Dorsalwand etwas rechts von der Mitte des Körpers endet. Dieser Sack enthält reifes Sperma, ist also ein Receptaculum seminis.

Zur Begattung bedienen sich die Tiere des am rechten Tentakel stehenden Anhanges. Das Sperma gelangt von der Mündung des Keimdrüsenganges an der rechten Seite des Kopfes herab zu einer Rinne (Fig. 12, r), die am Grunde des Copulationsorgans wahrzunehmen ist, und durch diese zu einer an der Ventralseite des Copulationsorgans vorhandenen schlitzförmigen Offnung, durch die sie aufgenommen wird. Das ganze Copulationsorgan stellt ein hohles Rohr dar. Vor und hinter der Öffnung wird dieses Rohr von einem hohen Drüsenepithel bekleidet (Fig. 12, cop), sodass dieser Teil wohl als eine Art Prostata anzusehn ist. Er mündet hinten durch eine enge Öffnung in einen darüber gelegenen weiten Abschnitt (Fig. 13) der von einem ziemlich niedrigen Epithel mit bläschenartigen Kernen bekleidet wird und eine Art Vesicula seminalis darstellt. Von hier geht ein langes enges Rohr dorsalwärts ab, das schräg nach oben und hinten gerichtet ist und bis zum Ende von dem engen Hohlraum durchsetzt wird. Dieses Copulationsorgan hat hier also einen recht komplicirten Bau.

Wenn man nun voraussetzen darf, dass die von mir untersuchte Art mit der von Pelseneer untersuchten nahe verwandt ist, was nach der Form des Körpers, nach dem, was ich von der Radula gesehn habe, sowie nach dem von Pelseneer abgebildeten Schnitt durchaus wahrscheinlich ist, so ist gegenüber Pelseneers Auffassung festzustellen, dass diese Gruppe unmöglich zu den Docoglossen gestellt werden kann. Schon die Radula, welcher das Hauptmerkmal der Docoglossen, die ablösbaren, harten, pigmentirten Schneiden der Rhachispartie, fehlt, sowie die Zwittrigkeit und der einzige Otolith in jeder Otocyste sprechen dagegen, wie schon aus Pelseneers Darstellung zu entnehmen ist. Aber nicht bloss diese Gründe, sondern noch viele andere beweisen dem, der den Organismus der Docoglossen kennt, dass Bathysciadium völlig verschieden ist, jene haben 2 Nieren, deren rechte ungemein ausgedehnt ist und sich ventral zwischen Eingeweiden und Fuss etwa bis zur Körpermitte, hinten bis zum Ende der Eingeweidemasse erstreckt, während die linke ziemlich rudimentär ist, die Keimdrüse liegt unter dem Darmtractus, es sind Speicheldrüsen vorhanden, der Kiefer hat eine wesentlich verschiedene Beschaffenheit, mit den Cerebralganglien ist ein Paar von Sublingualganglien, die durch eine Commissur zusammenhängen, verbunden, auf dem Nacken finden sich als Reste der verloren gegangenen Ctenidien 2 Papillen u. s. w.

Bis zu einem gewissen Grade macht die Kleinheit von *Bathysciadium costulatum* es verständlich, dass Pelseneer so weit vom richtigen Verständnis entfernt war und u. and. die Angabe machen konnte, dass 2 Nieren vorhanden sind, doch scheint er auch von den zu vergleichenden Formen nur geringe Kenntnis zu haben.

Es fragt sich demnach, wohin Bathysciadium im System zu stellen ist. Mir scheint nur die Gattung Cocculina, für die ich eine Gruppe Cocculinoidea aufgestellt habe, eine nähere Verwandschaft mit Bathysciadium zu besitzen (vgl. Wissenschaftl. Ergebn. d. Deutschen Tiefsee-Expedition, v. 7, p. 149–156). Schon äusserlich fällt auch bei Cocculina-Arten (*C. laevis* Thiele, *spinigera* Jeffreys) in der Fusssohle eine mittlere Erhebung auf, der rechte Tentakel zeigt häufig (besonders bei *C. spinigera*)[1] die Verbindung mit einem Copulationsorgan, die Kieme ist ein vom Grunde der Nackenhöhle entspringendes, nach rechts geneigtes, mehr oder weniger stark gefaltetes Blatt. Der Mantelrand ist einfach, ohne Tentakel. Augen fehlen; die Otocysten enthalten je einen runden Otolithen. Auch das Nervensystem dürfte ganz ähnlich sein. *Cocculina*

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[1] Vgl. Dall in Bull. Mus. Comp. Zoöl., v. 18, p. 349. Dazu ist nur zu bemerken, dass die Art zwittrig ist, wie die beiden andern von mir beschriebenen Arten.

laevis hat über den Fussrändern einen Drüsenstreifen. Der Kiefer und die Zungenknorpel sind ähnlich, Speicheldrüsen fehlen, doch ist eine Vorderdarmdrüse vorhanden, der Magen ist weit, sackförmig, der Enddarm mündet an der rechten Seite der Nackenhöhle aus. Die einfache dorsale, links vom Enddarm gelegene Niere und das Pericardium in der linken Körperseite, endlich die zwittrige Keimdrüse mit ihrem an der rechten Seite verlaufenden, drüsigen Ausführungsgang und ein von der Nackenhöhle ausgehendes Receptaculum seminis zeigen mit Bathysciadium verglichen ganz ähnliche Verhältnisse.

Nur die Radula ist auffallend verschieden, sie hat bei Cocculina zahlreiche Seitenzähnchen, wie sie für die Rhipidoglossen charakteristisch sind, während Bathysciadium statt dessen nur die eine eigentümliche Seitenplatte besitzt; die Mittel- und Zwischenplatten dagegen lassen eher dieselbe Grundform erkennen, besonders die äusserste ist ähnlich, indessen hat Bathysciadium eine Zwischenplatte weniger als Cocculina.

Lepetella tubicola Verrill.

Von 2 Exemplaren dieser Art, die ich von Dr. Dall erhalten hatte, habe ich eins in Querschnitte zerlegt, von dem andern die Radula präparirt. Besonders im Verhalten des Fusses mit dem mittleren Wulst hat das Tier grosse Ähnlichkeit mit Bathysciadium, der Kopf ist verhältnissmässig kleiner, die Schnauze ist seitlich mit spitzen Lappen versehn, die beiden Tentakel sind einfach, ohne Copulationsorgan. Der Mantelrand ist glatt. Vorn an der rechten Seite entspringen von der Unterseite des Mantels einige Kiemenblättchen (Fig. 3).

Da die Conservirung des untersuchten Tieres nicht gut war, beschränke ich mich darauf, die Hauptmerkmale hervorzuheben.

Die Radula ist von Dall (Bull. Mus. Comp. Zoöl., v. 18, t. 25, f. 6) in der Hauptsache richtig abgebildet (Fig. 8). Die Mittelplatte ist breiter als lang, vorn fast gerade, nur mit 2 ganz schwachen Einbuchtungen, nach hinten verbreitert, auffallenderweise hat sie in der Mitte keine deutliche Schneide, dagegen jederseits eine kleine, deren Spitze schräg seitwärts gerichtet ist. Daran schliessen sich 2 Zwischenplatten jederseits, deren innere etwas länger als breit und mit einer deutlichen spitzen Schneide versehn ist, während die äussere bedeutend grösser und mit 3 nach der Mitte hin gewendeten Zähnen ausgestattet ist, deren äusserster am kleinsten ist. Die äusserste Platte hat keine Schneide, sie ist nach der Mitte etwas lappenförmig ausgezogen.

Unter der Zunge umgiebt eine mit dem Kiefer in Verbindung stehende Falte die Mundöffnung. Die Zungenknorpel sind im Querschnitt oval und zum grossen Teil mit einander verwachsen; unter der Radulascheide liegt ein kleiner accessorischer Knorpel (Fig. 16). Die Verhältnisse der Verdauungsorgane sind grösstenteils nicht zu erkennen, der Magen scheint umfangreich zu sein wie bei Bathysciadium, der Enddarm ist nicht so drüsig, er mündet nach rechts aus. Links von ihm findet sich die Niere, rechts der Ausführungsgang der Zwitterdrüse, in der die männliche Keimstoffe sich im Zustande der Reife befinden. Auch ein ganz ähnliches Receptaculum seminis, das rechts von der Keimdrüse ausmündet (bei rec in Fig. 16) ist vorhanden.

Wenn hiernach auch mit Bathysciadium verglichen einige Unterschiede bei Lepetella festgestellt sind, unter denen die wichtigsten sind die Gegenwart von einigen Kiemenblättchen an der rechten Seite des Mantels statt der Nackenkieme und das Fehlen eines Copulationsorgans am rechten Tentakel, so ist doch die Anordnung der inneren Organe und das Verhalten der Keimdrüse so ähnlich, dass beide Gattungen offenbar nahe mit einander verwandt sind. Die Radula von Lepetella hat eine Zwischenplatte weniger als Bathysciadium.

Addisonia lateralis Requien.

Von einem Tier, das mir Dr. Dall zur Radula-Untersuchung anvertraute, habe ich nur die äusseren Merkmale dargestellt (Figs. 4, 5).

Die Form des Fusses ist ähnlich wie bei Lepetella, nur tritt die Mitte der Sohle nicht so stark vor, der Kopf trägt jederseits einen Tentakel, am Grunde des rechten sehe ich einen Wulst, der an die Umgebung der Samenrinne vom Copulationsorgan von Bathysciadium erinnert, doch ist ein besonderes Copulationsorgan nicht vorhanden; die Schnauze hat keine deutlich ausgezogenen Seitenlappen (Fig. 5). An der Unterseite der rechten Mantelhälfte ist eine Reihe grosser Kiemenblätter angeheftet, die bis zum Hinterende des Tieres reichen und nach hinten kleiner werden, ihre Zahl beträgt etwa 30 (Abbildungen haben Verrill in Tr. Connect. Ac., v. 6, t. 29, und Dall in Bull. Mus. Comp. Zoöl., v. 18, t. 25 gegeben). Die Blättchen sind rundlich dreieckig, an der Spitze mit einem fadenförmigen Anhang (Fig. 6).

Die Dorsalseite lässt in der Mitte die Keimdrüse erkennen, deren Ausführungsgang nach vorn und rechts verläuft; daneben liegt jedenfalls der Enddarm, während weiter links das Herz sichtbar ist (Fig. 4).

Verrill und Dall haben auch die Radula abgebildet. Ich finde die Mittelplatte eiförmig, länger als breit, hinten abgestutzt, ohne deutliche Schneide (Fig. 9). Die erste Zwischenplatte, die schräg nach vorn gerichtet ist, ist mehr als doppelt so breit wie lang, auch ohne deutliche Schneide, die zweite Zwischenplatte ist ähnlich, aber nicht so breit. Darauf folgen 2 kleine Platten, die rundlich dreieckig, schmal, ohne Schneiden sind, weiter eine Platte mit einer etwas vorgebogenen, gezähnelten Schneide (Fig. 10), die nach der Mitte gewendet ist. Die äussersten Platten sind schwer zu erkennen, da sich 2 zum grossen Teil überdecken. Die innere liegt etwas vor der äusseren und ist mit einer Schneide ausgestattet, die aus einer grössern inneren und einer kleineren äusseren Spitze besteht (Figs. 9, 11); in Fig. 10 ist deren Basalplatte dargestellt. Die äusserste Platte hat an ihrer Innerseite gleichfalls eine Schneide mit 2 Zacken, deren äussere ausnahmsweise geteilt sein kann, diese Schneide legt sich über die nächstinnere Platte

(Fig. 11). Die Basis der äussersten ist etwa doppelt so breit wie lang, an ihrem Hinterrande fällt eine besonders nach der Mitte der Radula hin stark verdickte Leiste auf.

Ohne die Anatomie von Addisonia genau untersucht zu haben, ist es natürlich nicht möglich, mit Sicherheit ihre systematische Stellung anzugeben, zumal da ihre Radula doch höchst eigenartig ist. Mit Bathysciadium und Lepetella verglichen hat sie beträchtlich mehr Platten in jedem Gliede, jederseits von der Mittelplatte 7, während Bathysciadium 4 und Lepetella nur 3 haben. Immerhin scheinen mir diese beiden Gattungen die einzigen zu sein, neben die man Addisonia stellen kann. Da Lepetella wie erwähnt einige Kiemenblättchen an der rechten Mantelseite besitzt, würde hierin der Unterschied gegenüber Addisonia geringer sein als gegenüber Bathysciadium, deren eine Art nach Pelseneer gar keine Kieme, deren andere eine blattförmige Nackenkieme hat.

Im Ganzen mag Bathysciadium sich am nächsten an Cocculina anschliessen, dagegen Addisonia am höchsten und abweichendsten entwickelt sein. Ich möchte einstweilen vorschlagen, diese 3 Gattungen den Cocculinoidea einzufügen und Bathysciadium mit Lepetella in einer Familie Lepetellidae zu vereinigen, für Addisonia dagegen eine besondere Familie Addisoniidae beizubehalten.

Die Radula dieser beider Familien ist ja freilich nicht mehr als rhipidogloss zu bezeichnen, doch kann das allein natürlich keinen hinreichenden Grund abgeben, sie von den Rhipidoglossen auszuschliessen, wenn ihr ganzer übriger Organismus sie zu diesen verweist, wie ja auch einige Cyclostrematiden kaum noch ein rhipidoglosses Gebiss erkennen lassen.

TAFEL 1.

Fig. 1. *Bathysciadium pacificum* in Ventralansicht.

Fig. 2. Dasselbe Tier in Dorsalansicht nach Abtragung eines Teiles des Mantels, um die Kieme *b* zu zeigen.

Fig. 3. *Lepetella tubicola* in Ventralansicht.

Fig. 4. *Addisonia lateralis* in Dorsalansicht.

Fig. 5. Kopf desselben Tieres in Ventralansicht.

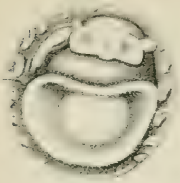
Fig. 6. Eins der mittleren Kiemenblätter desselben.

Fig. 7. Radula von *Bathysciadium costulatum: a*, 3 Mittelplatten; *b*, Zwischenplatten und Seitenplatte; *c*, die 2. Zwischenplatte; *d*, Seitenplatte stärker vergrössert.

Fig. 8. Teil der Radula von *Lepetella tubicola.*

Fig. 9. Halbes Glied der Radula von *Addisonia lateralis.*

Fig. 10. Die kleinen Zwischenplatten derselben stärker vergr.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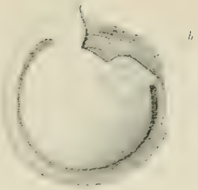

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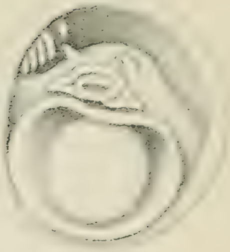
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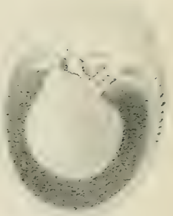
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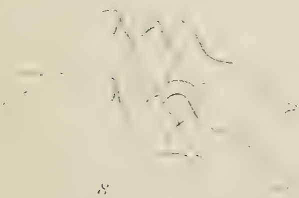
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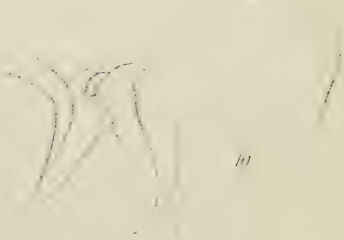
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TAFEL 2.

Fig. 11. Die beiden äussersten Platten, ebenso vergr.

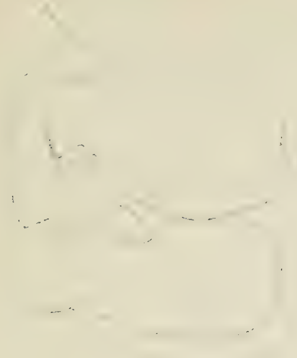
Fig. 12. Teil eines Querschnittes durch den Kopf von *Bathysciadium pacificum*, vor der Mundöffnung; *b*, Teil der Kieme; *cop*, Copulationsorgan mit der Samenrinne *r*; *gc*, Cerebralganglion; *kn*, Knorpel; *mx*, Kiefer.

Fig. 13. Schnitt durch das Copulationsorgan mit dem Anfang des dorsalen Fortsatzes.

Fig. 14. Seitenplatte der Radula derselben Art.

Fig. 15. Querschnitt desselben Tieres unmittelbar vor dem Fusse, links ist das Hinterende des Zungenknorpels getroffen, darüber bei *ov* das Vorderende der Keimdrüse; *rs*, Radulascheide; *st*, Magen umgeben von der Vorderdarmdrüse; *gl*, Drüsenstreifen; *i* und *fi*, Darm; *ir*, Enddarm (bis *i*, nach links reichend); *b*, Kieme (proximaler Teil); *n*, Niere; *p*, Pericardium mit Herz *c*; *gd*, Ausführungsgang der Keimdrüse; *rec*, Vorderende des Ganges zum Receptaculum seminis.

Fig. 16. Querschnitt durch den Kopf von *Lepetella tubicola*, der die Mundöffnung getroffen hat; *oe*, Vorderdarm, die übrigen Buchstaben wie in Figs. 12 und 15.



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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LII. No. 6.

ZOÖLOGICAL RESULTS OF THE THAYER BRAZILIAN EXPEDITION.

PRELIMINARY DESCRIPTIONS OF NEW GENERA AND SPECIES OF TETRAGONOPTERID CHARACINS.

BY CARL H. EIGENMANN.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
DECEMBER, 1908.

No. 6. — *Zoölogical Results of the Thayer Brazilian Expedition. Preliminary descriptions of New Genera and Species of Tetragonopterid Characins.*[1]

By Carl H. Eigenmann.

The following species, mostly collected during the Thayer Expedition, will be fully described and figured in a monograph of the Characidae to appear in the Memoirs of the Museum of Comparative Zoölogy.

The monograph will be issued at irregular intervals, and the account of the Tetragonopterinae, which forms the first section of the systematic part of the monograph, will be delayed on account of the desirability of securing material from some of the South American rivers flowing north into the Caribbean.

Gymnocorymbus, gen. nov.

Resembling Moenkhausia, from which it differs in the naked predorsal line.

Type. — *Gymnocorymbus thayeri*, sp. nov.[2]

Gymnocorymbus thayeri, sp. nov.

Head 3.5 (average); depth 1.7 (average); D. 11; A. 34–41, usually 37 or 38.

Very deep and very much compressed; the ventral outline much greater than the dorsal, pendant, deepest at origin of anal.

Snout very short, mouth very oblique.

Scales cycloid, regularly imbricate.

Color similar to that of *Tetragonopterus argenteus*. A dark humeral bar followed by a lighter area, and this again by a bar less well-marked than the first; area between the two bars, just above lateral line, bright silvery. Lower sides brassy; fins hyaline to uniform dusky.

Males with hooklets on anal.

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[1] Contributions from the Zoölogical Laboratory of Indiana University, No. 99.

[2] In memory of S. V. R. Thayer, a volunteer of the Thayer Expedition.

Second air-bladder more or less boot-shaped.

One hundred specimens, Amazons from Tabatinga to Gurupa.

Thayeria, gen. nov.[1]

Small, elongate Tetragonopterids, reaching a length of nearly 80 mm., distinguished from all others by the unequally lobed caudal.

Near Hemigrammus and Creatochanes.

TYPE. — *Thayeria obliquus*, sp. nov.

Thayeria obliquus, sp. nov.

Head about equal to depth, 2.6 (in young)–3 in the length. D. 10½–11; A. 16 or 17, rarely 15 or 18.

Little compressed, elongate, at occiput little deeper than length of head.

Brassy; anterior anal lobe dusky; a light bar from base of upper caudal rays obliquely to tips of the three short rays above the middle; a dark band from middle of caudal forward; no humeral spot.

Many specimens, 47–76 mm. ♂, ♀, Obidos.

Ctenobrycon, gen. nov.

This genus differs from all other Tetragonopterinae by its ctenoid scales, which are especially rough on the breast. In other respects it resembles the deeper species of Astyanax.

TYPE. — *Tetragonopterus hauxwellianus* Cope.

Astyanax asymmetricus, sp. nov.

Distinguishable from all other members of the genus by the triangular, asymmetrically placed, caudal spot.

Head 3.3–3.7; depth 3–3.3; D. 11; A. 30, 32, and 28; scales 11 or 12–54 or 55–59; eye 2.5–2.75 in the head; interorbital 3.1–3.75.

Compressed, symmetrically elliptical to the slender caudal peduncle. Occipital process about one-fourth the distance of its base from the dorsal. Snout long and pointed. Maxilliary long and slender, about as long as the eye. Three or four teeth in front row of premaxillary, — if four the third is out of line; five teeth in second series, the denticles arranged in a nearly straight line; two very minute teeth on the maxillary. Mandible half length of head.

All but the tips of the middle caudal rays black, the spot continued obliquely downward on end of caudal peduncle to its lower edge, otherwise immaculate.

Three specimens, 40 to 51 mm. long. Tabatinga.

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[1] In memory of Nathaniel Thayer, through whose liberality most of the species described in this paper were collected.

Astyanax symmetricus, sp. nov.

Allied to *A. asymmetricus*, *A. anterior*, and *A. zonatus*. Distinguished by the absence of a humeral spot and the nearly symmetrical caudal spot. Most nearly like *A. zonatus*, from which it differs, among other things, by the striation of the scales.

Head 2.66; depth $2\frac{7}{11}$; D. 11; A. 30; scales 8–48–6; eye 3; interorbital 2.66.

Brassy; a silvery lateral band; no trace of a humeral spot; middle caudal rays dark, the chromatophores scattered over base of neighboring rays.

One specimen, 74 mm. long. Tabatinga.

Astyanax zonatus, sp. nov.

Allied to *anterior* and *asymmtericus*; distinguishable from other members of the genus by a caudal "cross-bar."

Head 3.8; depth 3; scales 8 or 9–42 to 47–5 or 6; D. 11; A. 27–30; eye 2.56 in head; interorbital about equal to eye.

A faint vertical humeral spot, a spur of it crossing the third scale of the lateral line; end of caudal peduncle whitish; a broad, dark bar crossing base of caudal, blackest in the centre, where it is continued to the end, or nearly to the end of the middle rays. A narrow, silvery lateral band.

Alimentary canal not quite equal to the entire length.

Six specimens, 34 (to base of caudal) to 59 mm. long. Tabatinga.

Astyanax anterior, sp. nov.

Allied to *A. asymmetricus*; distinguishable from all other species of Astyanax by the anterior position and sublinear character of its humeral spot.

Head 3.5; depth 2.8; D. 11; A. 28–32; scales 9.5 or 10–52 or 53–56; eye 3+; interorbital 3.

A silvery lateral band about three in the eye; a horizontal black spot one-fourth as wide as eye and rather longer than the eye, beginning on upper part of the first scale of the lateral line and extending straight, pointed behind; middle caudal rays black. Otherwise plain.

Two specimens, 70 to 91 mm. long. Tabatinga.

Astyanax bourgeti, sp. nov.[1]

A well-marked species, differing from all others of the genus in the black lower fins.

Head 3.33; depth 2.33; D. 11; A. 34; scales 12–53–9; eye a little less than $\frac{1}{3}$ length of head; interorbital 2.47.

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[1] In memory of Monsieur Bourget, who collected the species described as new in this paper from Tabatinga.

A large, well-defined, horizontally ovate humeral spot on upper part of first to fifth scale of lateral line, and above those scales a conspicuous silvery spot on its upper, anterior corner; a narrow, faint silvery band; a conspicuous black spot, about as large as the pupil on base of middle caudal rays; tips of middle half of caudal rays dusky; anal nearly uniformly dark; pectorals and ventrals profusely dotted, nearly black.

One specimen, 92 mm. long. Tabatinga.

Astyanax bimaculatus borealis, var. nov.

Tetragonopterus maculatus Steindachner, Fischf. Magd. Stromes, 1878, 42, Rio Magdalena; Fischf. Cauca & Flüsse Guayaquil, 1880, 21, Cauca. In nine specimens from the Cauca and Magdalena Steindachner had one with 32 anal rays, three with 38, and the rest with between 36–39. This gives 38 as the usual number, and the average 37. The nearest average in any other locality is 32.2. This difference is worthy of nominal recognition.

Astyanax janeiroensis, sp. nov.

This species is closely related to *A. bimaculatus*, but differs conspicuously from typical specimens from Rio de Janerio in its much more elongate form.

Head 4; depth $2\frac{5}{6}$; D. 11; A. 27; scales 6–38–5; eye 3.5; interorbital $2\frac{3}{8}$; two maxillary teeth.

Anal basis equals the space between the dorsals (greater than distance from base of last dorsal ray to tip of adipose in all specimens of *A. bimaculatus* from Rio). Width of body $2\frac{4}{11}$ in the depth, (3–3.4).

A faint basal caudal spot, not continued on the middle rays.

One specimen, 92 mm. Rio de Janeiro.

Astyanax goyacensis, sp. nov.

This specimen differs from all specimens of *A. bimaculatus* from Goyaz in the shape, so that it could not be confounded with them. It is much more elongate and heavier forward.

Head 4; depth $2\frac{5}{7}$; D. 11; A. 25; scales 7–38–5; eye 3.4; interorbital 2.25; width of body $2\frac{7}{11}$ in its depth (over three in *A. bimaculatus*). Jaws equal (teeth of outer row of premaxillary exposed in the closed mouth in *A. bimaculatus*); second suborbital covering entire cheek (leaving a naked margin in *A. bimaculatus*).

The narrow caudal spot continued to end of middle rays.

One specimen, 76 mm. (to base of caudal). Goyaz.

Astyanax brevirhinus, sp. nov.

Distinguished by the blunt snout.

Head $3\frac{5}{7}$; depth 2.4; D. 11; A. 28; scales 6–35–4; eye 2.5; interorbital 3.

Compressed, dorsal and ventral profiles equally arched.

A silvery lateral band, an obscure humeral spot; middle caudal rays hyaline with traces of color, the tips dark, the caudal lobes opaque.

One specimen, about 68 mm. long. Rio Jequitinhonha.

Astyanax giton, sp. nov.

These two specimens are *Astyanax taeniatus*, with a blunt snout. The larger may be considered the type. They differ from *A. brevirhinus* in the color of the caudal and the shape of the occipital process.

Head 4; depth 2.5–2.6; D. 11; A. 23–24; scales 5–35–4; eye 2.5; interorbital 2.75–3.

Occipital process not nearly so narrow as in *A. brevirhinus;* snout a little more than half as long as the eye.

A prominent humeral spot crossing the third scale of the lateral line; a large spot at base of caudal continued to tips of the middle rays. Otherwise as in *A. brevirhinus.*

Two specimens, about 68 to about 78 mm. Rio Parahyba.

Astyanax albeolus, nom. nov.

Astyanax oerstedii Meek, not Kröyer, Field Columbian Museum, Publication 1907, vol. 7, p. 145.

Head 4.5; depth 2.66; D. 11; A. 26; scales 7–38–7; eye equal to snout, 3.5 in head; interorbital ½ the head's length behind the second nareal opening.

A vertically oval humeral spot, the ventral prolongation scarcely evident, crossing the third and fourth scales of the lateral line. Dorsal whitish, having very few chromatophores; anal lobe without chromatophores, the rest of the fin with a few.

Very closely related to *A. globiceps.*

One specimen, 116 mm. Rio Machuca, Rio Siguires, Costa Rica.

Astyanax fasciatus parahybae, subsp. nov.

The specimens from the Parahyba basin differ from typical *A. fasciatus* in so many and so striking respects that they may also be distinguished by a varietal name.

Head 4.25–4.4; depth 2.5–2.66; D. 11; A. usually 31 or 32 (27–34 in *A. fasciatus*); lateral line usually 39 or 40 (37–41).

Rows of scales below the lateral line deflected toward the anal by interpolated rows of scales, the first of the interpolated rows beginning at a point above middle of ventrals and one or two rows of scales below the lateral line.

Tips of dorsal, caudal rays, and anal usually dark; tips of ventrals, sometimes and more rarely, the tips of the pectorals, also dusky; middle caudal rays dark; tips of first 2 rays of anal milk-white.

Many specimens, 36–138 mm. Rio Parahyba, Mendez, Muriahe, and Taubeté.

Astyanax scabripinnis intermedius, subsp. nov.

The true *A. scabripinnis* shades into the *A. taeniatus* Jenyns in these specimens. We have the elongate form, depth (about 3) of *A. scabripinnis;* the eye is larger, being about 2.5–2.75, rarely 3, in the head; head slender, pointed. A. 21 to 24 in the Parahyba specimens, 23 to 26 in the Santa Clara specimens; scales 37 to 39 from the Parahyba, lost from the Santa Clara specimens.

Many specimens, 38–113 mm. long. Rio Parahyba and Santa Clara.

Astyanax multidens, sp. nov.

One of the smallest species of the genus. Distinguished from its relatives *gracilior* and *paucidens* by the large number (5) of maxillary teeth, and the large second suborbital.

Head about 3.75; depth 3.33–3.25; D. 11; A. 24–26; scales 5 or 6–32 to 34–4; eye about 2.5 in head; interorbital about 3.

Straw colored in alcohol; a vertical, humeral spot above third and fourth scales of the lateral line; a narrow, silvery band, overlying a black line; caudal with the distal part of its middle rays dark, the black of the caudal separated by an interspace from the black line of the sides; tip of highest dorsal and anal rays sometimes milk-white; fins otherwise without markings.

Many specimens, 27 (to base of C.)–32 mm. (to base of C.). Obidos, and Silva, Lake Saraca.

Astyanax gracilior, sp. nov.

Closely related to *multidens*. The caudal spot is much more prominent, extending to the base of the rays; humeral spot very faint; depth 3.5–4; maxillary teeth three, about 5-pointed; five large dentary teeth; three teeth in outer row of premaxillary in two of the specimens, five in one; pectorals not reaching ventrals. A. 22–24; lateral line 36–37.

Three specimens, 35–63 mm. long. Obidos and Villa Bella.

Deuterodon pedri, sp. nov.

Head 4–4.33; depth about 3; D. 10 or 11; A. 22–27.

A little more slender than *D. iguape*. Second suborbital leaving a wide naked area; maxillary with 2 or 3 teeth.

A humeral spot, a silvery lateral band, and a large caudal spot continued, *apparently*, to end of middle rays.

To this species probably belong many specimens, 21–41 mm. long (to base of caudal) from Santa Cruz, collected by Dom Pedro II. On account of the poor condition of the types an absolute identification is impossible.

Seven specimens, 73–100 mm. long, in very poor condition, are undoubtedly a species of Deuterodon distinct from *D. iguape*.

Deuterodon parahybae, sp. nov.

Head 3.5–4; depth 2.5–3; D. 11; A. 24–26, usually 25.

Compressed elliptical; caudal peduncle as high as long. Second suborbital leaving a very narrow naked area; maxillary with 2 or 3 teeth; scales mostly fallen off, cycloid, with several slightly diverging striae.

A well-defined vertical, humeral spot; a large caudal spot, the middle caudal rays black.

Eight specimens, 46–53 mm. Itapemirim, Hartt & Copeland.

Pristella, gen. nov.

This genus differs from Hemigrammus as Hemibrycon differs from Astyanax.

Lateral line incomplete; caudal naked? Premaxillary with two series of teeth, those of the outer series with parallel margins, a prominent, broad, central lobe and two receding shoulders, the teeth becoming conical toward the sides, the posterior series within margin of jaw 1-pointed or 3-pointed incisors, with the middle much the higher; *maxillary with minute conical teeth scattered along most of the margin;* lower jaw with a single series of teeth, imperfectly tricuspid, the points broad, not unlike those of the upper jaw, graduated, the lateral teeth minute, conic; snout and maxillary 2–2.5 in head; gill-rakers long, setiform; gill membranes free from each other and from isthmus.

TYPE. — *Holopristes riddlei* Meek.

Psellogrammus, gen. nov.

Allied to Hemigrammus, but with the lateral line extending with interruptions to the caudal, the anal originating under the origin of the dorsal or still further forward.

TYPE. — *Hemigrammus kennedyi* Eigenmann.

Hemigrammus coeruleus DURBIN, sp. nov.[1]

Head 3.5; depth 2.75; D. 11; A. 20–22; scales 5–31 or 32–3½, 7 or 8 with pores; eye 2.5–2.66 in head; interorbital equal to eye. Maxillary a little longer than the eye, with four or five, sometimes two or three, tricuspid teeth.

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[1] The descriptions of the species of Hemigrammus and of Hyphessobrycon are the work of Miss Marion Lee Durbin, an able and earnest student of the Characins.

A highly iridescent-blue stripe along one row of scales between base of pectoral and middle of anal fin.

Distal $\frac{2}{3}$–$\frac{3}{4}$ of dorsal much darkened, especially in males; distal half of the first five, and tips of most of the remaining anal rays, the middle caudal rays, and the ventrals, also blackish. A silvery lateral band, $\frac{2}{3}$ of a scale wide from eye to caudal, below which is a grayish-brown stripe, faint and terminating in the middle of the caudal fin. A vertically elongate, roughly diamond-shaped, humeral spot, margined on each side by a faint, silvery line. Pale, bluish-gray iridescence below the stripes.

One hundred and three specimens, 42–52 mm. long (the type of 46 mm.) Manacapuru. Wm. James.

Hemigrammus levis Durbin, sp. nov.

Head 3.5–3.66; depth 3.2–3.6; D. 11, rarely 10; A. 17–20; scales 5–30 to 34–$3\frac{1}{2}$, 5 to 11 with pores; eye 2.5–2.66 in head; interorbital slightly less than eye.

Maxillary without teeth; a round caudal spot, other fins plain; a slaty-black lateral band below the dorsals and a silvery band below it.

Over 300 specimens, 33–47 mm. long. Lago do Maximo, Obidos, Villa Bella, Lake Jose Assu.

Hyphessobrycon Durbin, subgen. nov.

This genus is a Hemigrammus with a naked caudal.

Type. — *Hyphessobrycon compressus* (Meek).

Hyphessobrycon compressus milleri Durbin, subsp. nov.

Sides of head and body everywhere with numerous chromatophores; dorsal dark. Maxillary considerably less than the length of the eye. Second suborbital covering two-thirds of cheek, otherwise as in *H. compressus*.

One specimen, 40 mm. long. Los Amates, Guatemala.

Hyphessobrycon serpae Durbin, sp. nov.

Head 3.5; depth $2\frac{3}{4}$–3; A. 27–30. D. 10, rarely 11; scales 5–5+24–$3\frac{1}{2}$; eye 25–2.75; interorbital 3+.

A round, black spot of variable size on the dorsal, margined above on the second and third rays with white and below by a narrow white bar, which is widest on the first ray. Bases and tips of all the rays but the first without pigment; a submarginal bar of black on the first anal rays, and distinct marginal bar on the last rays. Some specimens with the intermediate rays also tipped with black. A humeral spot.

20985. Forty-six specimens, 26–30 mm. long. Serpa.

Hyphessobrycon copelandi Durbin, sp. nov.[1]

Head 3.5–3.8; depth 3–3.2; D. 11; A. 28; scales 5–7+24 to 27–3$\frac{1}{2}$; eye 2.25–2.33; interorbital 2.8–3. Five teeth in the second row of the premaxillary. First six rays of the dorsal with a submarginal black bar, bordered above and below with chalky white. Anal usually plain. A vertical humeral spot. Margin of caudal dusky. Outer rays of ventrals and pectorals chalky-white.

A hundred specimens, 29–42 mm. long. Tabatinga.

Hyphessobrycon bentosi Durbin, sp. nov.[2]

Distinguished by having eight teeth in the inner series of the premaxillary.

Head 3.33–3.5; depth 2$\frac{5}{6}$–3$\frac{1}{6}$; D. 11; A. 27–30; scales about 30–33; eye 2.5; interorbital less than eye.

First three dorsal rays tipped with white; a black spot bordered by white on distal half of the second to the sixth ray; basal part of dorsal hyaline; a humeral spot, no caudal spot.

Twenty-one specimens, 30–38 mm. long. Obidos.

Hyphessobrycon panamensis Durbin, sp. nov.

Head 3.4; depth 2.8; D. 11; A. 25; scales 7–12+24–6; eye 2.25 in head; snout 4; interorbital 3.

Upper scales margined with dusky; a dusky lateral band; first half of anal tipped with black, other fins plain.

Seven specimens, 29–32 mm. long. Panama.

One specimen, 32 mm. Boqueron River, Panama.[3]

Hyphessobrycon melazonatus Durbin, sp. nov.

Head 3.5; depth 2.66–2.5; D. 11; A. 22; scales 5–34–3.5; eye 2.66 in head; interorbital equals eye; a narrow naked border on the cheek.

Webs of the dorsal and sometimes those of the first seven or eight anal rays dusky; caudal peduncle largely dark; a very faint humeral spot.

One specimen, 38 mm. long. Lago do Maximo.

One specimen, 34 mm. Silva, Lake Saraca.

Moenkhausia latissimus, sp. nov.

Resembling *M. steindachneri* in coloration and compressed preventral region and keeled predorsal area. Distinguished by the entire scales, the small nuchal scale and much longer anal, etc.

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[1] In memory of Herbert Copeland of the Thayer Expedition.

[2] In memory of Colonel Bentos, a volunteer of the Thayer Expedition.

[3] This specimen was submitted for examination by Dr. B. W. Evermann.

Head 3.75; depth 2 (average); D. 11; A. 33–35.

Form very deep, compressed. Occipital process narrow, long.

No caudal spot; a well-defined, narrow, but very long humeral spot reaching from above the third to above the ninth scale of the lateral line.

Many specimens, 55–92 mm. Tabatinga.

Moenkhausia jamesi, sp. nov.[1]

Head 4; depth 2.2; D. 11; A. 33–35.

Deep, compressed. Occipital process moderate.

A dark, vertical caudal spot on base of all but the outermost rays, not continued on middle rays. A silvery lateral band half as wide as eye. An ill-defined, vertical humeral spot of scattered cells over the space between fourth and seventh scale of lateral line. No other dark markings. Iridescent silvery and brassy (except in a vertical area, three scales wide and about six high, beginning at the third scale of the lateral line).

Five specimens, Iça Obidos, Lago do Maximo, Tajapuru.

Monkhausia comma, sp. nov.

This species is readily distinguished by the elevated dorsal and peculiar humeral spot.

Head 3.4; depth 2 +; D. 11; A. 26.

Deep, compressed, subrhomboidal, the anal basis much steeper than the predorsal profile.

A well-defined horizontal, comma-shaped humeral spot above the first seven scales of the lateral line; a very narrow, silvery lateral line; upper posterior parts of the interradial membranes of dorsal dark, other fins hyaline.

Two specimens, 77 mm. Cudajas.

Moenkhausia justae, sp. nov.[2]

It differs from jamesi in having a tooth on the maxillary, the tooth 4-or 5-pointed; four teeth on each side of the lower jaw.

A. 31; scales 7–36–6; the second preorbital much narrower than in *M. jamesi.*

One specimen, 60 mm. from Dr. Justa through Major Cotinho.

Moenkhausia melogrammus, sp. nov.

Readily distiuguished by the depth and by the black line along base of anal.

Head 4; depth 2.5; D. 11 (divided ray counted as 2); A. 26.

Compressed, dorsal and ventral outlines nearly equal.

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[1] For William James, a member of the Thayer Expedition.

[2] For Dr. Justa.

Third tooth of the outer series of the premaxillary entirely withdrawn from the line of the rest.

A black line along base of anal; a faint dark line along the sides, otherwise faintly silvery, without spots.

One specimen, 40 mm. (to base of caudal). Tabatinga.

Moenkhausia australe, sp. nov.

Differs from *oligolepis* in number of scales in the lateral line, 24–26.

Two specimens, 33-41 mm. long. Arroyos Trementina and Chagalalina.

One of the few species of this genus extending south of the Amazon.

Moenkhausia barbouri, sp. nov.[1]

Very similar to *M. heterolepis*, the striae of the scales different and the caudal lobes dark.

Head 4.2–4.3; depth 2.4; D. 11; A. 30–33.

Compressed, moderately deep; dorsal and ventral profiles symmetrically curved.

Four or more diverging striae on each of the lateral scales.

A faint, vertical humeral spot; tips of caudal lobes and middle rays faintly dusky; a well-defined silvery lateral band two-thirds as wide as the eye; sides iridescent silvery.

Two specimens, 62 and 66 mm. Villa Bella.

Moenkhausia dichrourus intermedius, subsp. nov.

These typically colored specimens have a slender maxillary whose anterior margin is not greatly arched; the premaxillary has a much greater anteroposterior extent than in typical *dichrourus*. Occipital process $\frac{1}{3}$ the space from its base to the dorsal.

Two specimens, 42 to 64 mm. Tabatinga.

Moenkhausia lepidurus latus, subsp. nov.

These specimens differ from others from the Tapajos, and from various other localities. Anal rays average 26+. Body deeper, the depth averaging 2.6 of the length.

Middle caudal rays faintly colored, if at all; upper caudal lobe black.

Many specimens, 55 to 75 mm. Rio Tapajos.

Moenkhausia lepidurus içae, subsp. nov.

Deep, compressed; depth 3; anal rays usually 23 or 24.

Upper caudal lobes and sometimes distal part of other rays dusky; a very small, well-defined humeral spot of about ten chromatophores; tip of anal lobe sometimes milk-white.

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[1] For Mr. Thomas Barbour of Cambridge.

Many specimens, 30 to 50 mm. long. Içа.

Moenkhausia lepidurus gracilimus, sp. nov.

Anal averaging 22 rays; depth 4 or nearly 4.

Color of caudal as in typical individuals of *lepidurus* but faint, with a duskiness extending upon the lower caudal lobe.

Humeral spot, even in the smallest examples, of over 20 chromatophores, not well defined.

Also seventeen specimens, 47–59 mm. long, from Villa Bella.

Middle caudal rays and distal part of the other rays, and upper and lower edges of the fin, dusky; tip of anal lobe sometimes milk-white; humeral spot of many chromatophores, extending upward from second and third or third and fourth scales.

These specimens are appreciably different from the typical *M. gracilimus*, but gradations between them are almost perfect.

Twenty-one specimens, about 39 to 57 mm. Serpa.

Moenkhausia cotinho, sp. nov.[1]

Distinguished by the slender form combined with the broad, basal caudal bar.

Head $3\frac{5}{6}$–$3\frac{5}{7}$; depth 3+; D. 11; A. 20 or 21; scales 5–32–3.5.

Elongate, not strongly compressed or elevated.

Occipital process short, reaching one-sixth the distance to dorsal.

Three or four teeth in outer series of the premaxillary, five teeth in the second; two teeth in the premaxillary. Lower jaw with four large teeth followed by a much smaller, recurved tooth and a number of minute teeth.

Brassy, the fins dusky; a very large and very conspicuous vertically oval black spot on base of caudal, bordered behind by milk-white.

Three cotypes 67–71 mm. from Para, Thayer Expedition, are much paler; the caudal spot, although covering the same area, is very faint except that part not covered by the caudal scales.

Two specimens, 46 and 54 mm. Dr. Justa, by Major Cotinho.

Moenkhausia ceros, sp. nov.

Distinguished by the caudal spot and the short anal.

Head 4; depth 3.25; D. 11; A. 19; scales 5–33–3.

Elongate, compressed; dorsal and ventral profiles gently curved. Occipital process short, reaching about one-sixth to dorsal, bordered by three scales on each side.

Four teeth in the front series of the premaxillary, inner series of six graduated teeth; four large, graduated teeth in the lower jaw, and numerous small ones.

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[1] For Major Cotinho, Brazilian attaché of the Thayer Expedition.

Third anal ray of ♂ (i. e., the first fully-developed ray) provided with a large retrorse hook on each side.

A faint, ill-defined, silvery lateral band with a gray line above it. Middle caudal rays jet black, the color spreading over base of fin. Scales and fins minutely punctate. Sides brassy, iridescent. No humeral spot.

One specimen, 50 mm. long. Lake Hyanuary.

Bryconamericus heteresthes, sp. nov.

The most slender species of the genus.

Head $4\frac{1}{4}$; depth 3.75–4.25; D. 10 (everything counted); A. usually 19.

Slender, very little compressed, the width about one-half the depth.

Occipital process very short, about 8 in the space from its base to the dorsal, bordered by two scales.

Four or five, rarely six, teeth in the front row of the premaxillary, the *second* withdrawn from the line of the others.

Scales deeply imbricate, *without striae.*

Highly iridescent silvery; a silvery lateral band, two-thirds as wide as eye, from humeral spot to caudal; a vertical humeral spot; a few pigment cells on upper part of opercle and preopercle. Fins hyaline, without chromatophores. Anterior anal rays of males with numerous recurved hooklets.

Many specimens, 27–49 mm. long. Tapajos.

Bryconamericus stramineus, sp. nov.

Head 4.5–4.75; depth 4.25–4.5; D. 10; A. about 22.

Extremely slender, elongate, the ventral profile slightly more arched than the dorsal.

Occipital process very short, about 8 in the space from its base to the dorsal.

Scales cycloid, everywhere regularly imbricate.

Straw colored in alcohol; a conspicuous silvery band; a very faint humeral spot; middle caudal rays with faint dots.

Three specimens, 44 to 49.5 mm. Piracicaba and Uruguay River.

Bryconamericus boops, sp. nov.

Head 4; depth 3.6; D. 10; A. 22.

Elongate, sciaenoid. Gill-rakers very short, about 8+12.

Frosted silvery. A humeral spot above the fourth and fifth scales of the lateral line; a plumbeous lateral band becoming darker on the caudal peduncle; middle caudal rays dusky; dorsal dusky except tips of first two rays.

One specimen, about 76 mm. in total length (60 mm. to base of C.). Maldonado.

Bryconamericus breviceps, sp. nov.

Distinguished by the short head and the small fins.

Head 4.5-4.66; depth ♂ and spent ♀ about 3; ♀ with eggs 2.66–2.8; D. 10-11; A. 20–23.

Occipital process very short, not reaching $\frac{1}{9}$ the distance from its base to the dorsal. Suborbital covering the entire cheek; maxillary not much longer than snout, 3.3 in head.

Gill-rakers very short, $\frac{1}{4}$ diam. of eye, 6+10.

Many specimens, about 65–87 mm. long. Goyaz.

Bryconamericus peruanus ricae, sp. nov.

The specimens from Costa Rica have the origin of the dorsal an orbital diameter nearer snout than to base of middle caudal rays. Scales 7–39 or 40–6; D. 10 or 11; A. 28–31. Eye 3 in the head, much larger than in *B. peruanus* of the same size; interorbital equal to eye.

Three specimens, 84–95 mm. long. Chitaria, Costa Rica.

Brycochandus, gen. nov.

This genus is a Creatochanes with an incomplete lateral line.

Type. — *Brycochandus durbini*, sp. nov.

Brycochandus durbini, sp. nov.[1]

Head 4.2; depth 3.66–3.75; D. 11; A. 27; scales 6–39 to 40–4; lateral line with pores on the first 30 scales; eye 2.4 in the head, interorbital 2.5.

Compressed slender; mouth large, maxillary equal to length of eye. Maxillary with two wide, 3-pointed teeth and about two minute, conical ones.

A round, hyaline spot equal to the length of the middle caudal rays covering the basal portion of the upper lobe. Caudal otherwise dark. A narrow, blackish lateral stripe subtended by the broad silvery stripe.

Two specimens, 38 and 39 mm. long. Rio Tapajos.

Creatochanes gracilis, sp. nov.

Head 4.5; depth 4.33; D. 11; A. II, 31$\frac{1}{2}$; scales 8–54–3$\frac{1}{2}$; (above ventrals), 5 above anal. Maxillary not reaching to end of second suborbital, its length 2.5 in the head. Premaxillary teeth $\frac{4}{5}$; large mandibulary teeth 5; maxillary without teeth.

Greatest depth anterior to middle of body.

Similar to *C. melanurus*.

One specimen, 75 mm. long. Rio Tapajos.

Poptella, gen. nov.

This genus differs from Gymnocorymbus by having a hidden predorsal spine. It is most nearly related to Fowlerina.

Type. — *Tetragonopterus longipinnis*. Popta.

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[1] For Miss Marion Lee Durbin.

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NOTES ON SOME AUSTRALIAN AND INDO-PACIFIC ECHINODERMS.

By Hubert Lyman Clark.

With One Plate.

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No. 7. — *Notes on some Australian and Indo-Pacific Echinoderms.* By Hubert Lyman Clark.

The Trustees of the Australian Museum having placed in my hands the collection of echinoderms made by the "Thetis" in 1898, it has seemed desirable before studying that collection to work over the Australian material in the M. C. Z. collections and to describe the new forms. I have to thank Mr. Robert Etheridge, Curator of the Museum, for his courteous approval of this plan. I have found that the ophiurans of the genera Pectinura and Ophiopeza offer some peculiar difficulties and it has been necessary to make a very careful study of those genera and their allies. This has led to a complete revision of all the known species of ophiurans of that group (which may be styled Ophiarachna *sensu* Müller and Troschel + Ophiopeza *sensu* Peters), and I incorporate my results in this paper.

ASTEROIDEA.

ASTROPECTINIDAE.

Astropecten.

The M. C. Z. collection contains half a dozen Astropectens from the coast of New South Wales. Two of these are without doubt *A. polyacanthus* M. and T., but the other four are less easy to determine. One was received in exchange from the United States National Museum and is labelled "Astropecten triseriatus M. & T., Botany Bay, Australia." The other three are undoubtedly the same species and are so labelled, but were received from the Australian Museum, and were collected off Port Jackson. These specimens agree well with Müller's and Troschel's description of *A. triseriatus*, except in the most important point. The large spines on the supramarginal plates are in a single series and there is no trace of the second and third series, characteristic of Müller's and Troschel's species, except that on a very few plates a second small spine is present close beside the principal one. I see no reason to doubt that this is the *A. triseriatus* of Whitelegge's list (Journ. Roy. Soc. N. S. W., **23**, p. 200), but that it is the *A. triseriatus* of Müller and Troschel seems to me very doubtful. Except for the fact that the ventral and marginal spines are strongly flattened instead of being cylindrical, I should have no hesitation in referring these specimens to Sladen's *A. acanthifer* from the Banda Sea, but the difference in the spines is so marked I hardly think such identification would be correct.

GONIASTERIDAE.

Goniaster tessellatus.

Asterias tessellata Lamarck, 1816. Anim. s. Vert., **2**, p. 552.
Goniaster tessellatus Agassiz, 1835. Mem. Soc. Sci. Neuchatel, **1**, p. 191.

As this species has not been recorded from Australia, it may be of interest to note a specimen, labelled "Melbourne, Aust.," which is indistinguishable from those taken at Zanzibar.

Goniodiscaster, nom. nov.

Fisher (1906, Starfishes Haw. Isl., p. 1070) has proposed the name Goniodiscides for a group of starfishes, long known as Goniodiscus. Fisher shows that the name Goniodiscus is untenable, but in order to disturb nomenclature as little as possible, he altered only the termination. Unfortunately, however, he selected for his type the well-known species, *Goniodiscus sebae*, which I have recently shown (Bull. M. C. Z., **51**, p. 281) is simply the young of *Culcita novae-guineae*, and therefore Goniodiscides is a synonym of Culcita. I therefore propose the name Goniodiscaster with *Asterias pleyadella* Lamarck as the type-species.

Goniodiscaster pleyadella.

Asterias pleyadella Lamarck, 1816. Anim. s. Vert., **2**, p. 553.
Pentagonaster validus Bell, 1884. "Alert" Rept., p. 129.
Goniodiscus pleyadella Döderlein, 1896. Semon's Zoöl. Forsch., **5**, p. 308, pl. 18, figs. 34–34f.
Goniodiscides pleyadella Fisher, 1906. Starfishes Haw. Isl., p. 1070.

We are so fortunate as to have in the M. C. Z. collection two excellent specimens of "*Pentagonaster validus*" Bell, which were received in exchange from the British Museum. After a careful comparison of these specimens with Döderlein's (l. c.) excellent photographs, I am satisfied that Bell's species is identical with that which Döderlein calls *G. pleyadella* Lam., so that unless Döderlein is guilty of a serious mistake, Bell's proposed name becomes a synonym of Lamarck's.

Goniodiscaster coppingeri.

Pentagonaster coppingeri, Bell 1884. "Alert" Rept., p. 128.

There is a specimen in the M. C. Z. collection from Adolphus Island, near Cape York, Australia, with rays 72 mm. long, which differs from Bell's description only in color. It is deep brick-red and has apparently never been in alcohol. The species is very distinct from the preceding, but appears to be congeneric with it.

LINCKIIDAE.

Hacelia helicostichus.

"*Linckia nodosa* Perrier" Bell, 1884. "Alert" Rept., p. 124.
Ophidiaster helicostichus Sladen, 1889. "Challenger" Ast., p. 405, pl. 69, figs. 5–7.

Among the starfishes received in exchange from the British Museum, in 1907, is a handsome specimen labelled "*Linckia nodosa*." It is from Prince of Wales Channel, Torres Strait, 7 fms., was collected by the "Alert," and has the rays 118 mm. long. It must be therefore one of those referred to by Bell (l. c.) in the "Alert" Report. Comparison with a specimen of *L. nodosa* of about the same size, labelled by Perrier, shows, what a careful reading of Perrier's description clearly indicates, that the two species are not even congeneric. The Torres Strait specimen is evidently a fine example of Sladen's *Ophidiaster helicostichus*, which was taken by the "Challenger" in Torres Strait. Our specimen has the rays wider at the base than is shown in Sladen's figure, but otherwise shows no peculiarities. The tips of the rays have a bluish tinge which may indicate that the species in life is blue, like *Linckia laevigata*. There can be no question, I think, that this species is congeneric with *Hacelia attenuata* Gray of the Mediterranean.

OPHIUROIDEA.

OPHIODERMATIDAE.

The Genera Ophiarachna *s. lat.* and Ophiopeza.

The genus Ophiarachna Müller and Troschel was established in 1842 with four species, one of which (*O. incrassata* Lamk.) was readily distinguishable from the others (*O. gorgonia*, *O. infernalis*, and *O. septemspinosa*) by its few, long, stout arm-spines and concealed radial shields. The same year the genus Pectinura was established by Forbes for a very small ophiuran (*P. vestita*) from the Ægean Sea, which would naturally have gone in Ophiarachna had Forbes known of the existence of that genus. In 1851 Peters established Ophiopeza for a species (*O. fallax*) from Mozambique, distinguished from Ophiarachna and Pectinura by the lack of supplementary oral plates. In 1856 Lutken described a second species of Ophiopeza (*O. yoldii*) which he subsequently made the type of a new genus, Ophiopsammus. Ten years later Ljungman described two new Ophiarachnas, one (*O. spinosa*) from Fua, Tonga Islands, the other (*O. stellata*) from Singapore. The next year Grube redescribed the latter under the name *Ophiolepis* (*Ophiochasma*) *adspersa*. In 1869 Lütken made the first attempt at a revision of the group, removing from Ophiarachna *O. gorgonia*, *O. infernalis*, and *O. septemspinosa*, leaving *O. incrassata* as type of the genus and adding a new species (*O. affinis*) thereto. He went still further and separated Ophiarachna from its former ally, Pectinura, to which he had added several species, and associated it with Ophiocoma instead. He refers to the fact that the character which was supposed to distinguish Ophiopeza from Pectinura (*i. e.* the absence of supplementary oral plates) is not constant, as he found specimens of Ophiopeza which had one or more such plates.

In 1872 Ljungman adopted most of Lütken's suggestions but added two new genera (for which, however, he unfortunately failed to designate types), one (Ophiopezella) appears to be for his species, *O. spinosa*, and the other (Ophiarachnella) for *O. gorgonia* (and possibly *O. infernalis* and *O. septemspinosa*). Lyman never accepted either of Ljungman's genera, or Grube's Ophiochasma, or Lütken's Ophiopsammus, but he followed Lütken's lead as regards Ophiarachna's association with Ophiocoma, and in recognizing the two genera Pectinura and Ophiopeza. He, however, refers several times to the unsatisfactory nature of the character which was supposed to distinguish the two latter. Except for the recognition of Ophiopezella by de Loriol and Koehler, Lyman's classification has been used with scarcely any modifications down to the present day. Several writers have referred to the inconstancy of the presence or absence of supplementary oral plates, but no one has ventured to attempt a different grouping of the species. De Loriol, some years ago, called attention to the close resemblance between Pectinura and Ophiarachna, but it has apparently been agreed that such resemblance was simply parallelism and not an indication of relationship.

Taking up the question *de novo*, I have been forced to the conclusion that Lütken's separation of Ophiarachna from the Pectinura group and its association with Ophiocoma was unfortunate, and can only be rectified by a complete return to the position of Müller and Troschel that *O. incrassata* is closely allied to *O. gorgonia* and its allies. If we consider the morphological characters of the three genera concerned we find that they all have the disc covered with scales, which are concealed by a close granulation that often covers the radial shields and may even extend out a little way on the arms. In Ophiocoma and its allies the arm-spines arise from a ridge occupying approximately the vertical mid-line of the side arm-plate, and they stand out at nearly a right angle from the surface of the plate. In Pectinura and its allies the arm-spines arise from the distal margin of the side arm-plate and are generally more or less flattened and appressed to the arm; not infrequently there are notches in the proximal margin of the next plate into which they may fit. At first sight the arm-spines in Ophiarachna appear to be of the Ophiocoma type, for they are long and thick and often stand out at a decided angle from the arm. It was mainly on the strength of this character that Lütken and Lyman agreed on the association of Ophiarachna with Ophiocoma, but a careful examination of the genera concerned has satisfied me that even in its arm-spine arrangement Ophiarachna is nearly allied to Pectinura. While there is, in most specimens, a distinct ridge from which the spines arise, it does not occupy the median part of the plate as in Ophiocoma, but is really only the thickened distal margin of the plate; and furthermore, in many, if not in all cases, the proximal margin of each side arm-plate shows notches like those found in Pectinura. It is clear then that in Ophiarachna we have a genus allied to Pectinura, in which the increase in size of the arm-spines has led to a superficial resemblance to Ophiocoma. Such species of Pectinura as *P. septemspinosa*, with its greatly elongated lowest spine, and of Ophiopeza, as *O. danbyi*, with its four, long, thick arm-spines, indicate clearly how such a group might arise.

The evidence afforded by the arm-spines is strongly confirmed when we take into account the other morphological characters of the genera concerned. De Loriol long ago called attention to the fact that in some way a serious error has slipped into the diagnosis of Ophiarachna, for Lyman and others have said that the genus was characterized (as is Ophiocoma) by a cluster of tooth-papillae at the apex of the jaw. As a matter of fact Ophiarachna differs sharply from Ophiocoma in this particular; there are no tooth-papillae, but the teeth and oral papillae are strikingly like those of Pectinura. Another error in Lyman's diagnosis of Ophiarachna is the statement, "one or two tentacle-scales." As a matter of fact there are always two tentacle-scales, and they are arranged as in Pectinura and its allies, with the outer one overlapping the base of the lowest arm-spine. In Ophiocoma and its allies, on the other hand, if two tentacle-scales are present, the outer one does not overlap the base of an arm-spine.[1] The internal anatomy of the jaw-frames, moreover, is, in Ophiarachna, like that of Ophiopeza and quite different from that of Ophiocoma (see p. 127). In the presence of supplementary oral plates and of pores between the basal under arm-plates, Ophiarachna differs markedly from Ophiocoma and shows a strong resemblance to several species of Pectinura.

In consideration of all these facts, it seems clear that Ophiarachna is a near ally of Pectinura, with the arm-spines showing an interesting parallelism to Ophiocoma. Indeed it is by no means easy to point out any character or group of characters by which all the species of Ophiarachna can be readily separated from all the species of Pectinura and Ophiopeza.

Another conclusion to which my investigations have led is that the complaints which have arisen from time to time in regard to the inconstancy of the difference between Pectinura and Ophiopeza are well grounded, and that the two genera cannot be distinguished by the presence or absence of the supplementary oral plates. I have before me two excellent specimens of *Pectinura maculata* Verrill, in one of which the supplementary plates are well developed, while in the other they are wholly wanting. On the other hand, *Ophiopeza fallax* Peters has long been known to vary greatly in this respect, some specimens showing one or more of the supplementary plates. The specimens of *Ophiopeza cylindrica* Hutton, which are accessible, are all Pectinuras in this particular, for one has one, one has four, and one has five supplementary plates. Moreover in several of the deep-sea species which have been referred to Pectinura, the supplementary plates are so rudimentary that it becomes a question of mere personal opinion whether they are present or not. It seems therefore very unwise to attempt to maintain any longer the artificial line which has so long separated Ophiopeza from Pectinura. Since the latter genus was established, no less than 34 species have been referred to it; of these, *P. forbesi* Heller has been made the type of Ophioconis by Lütken, *P. spinosa* Ljungman is the type of Ophiopezella, and *P. verrucosa* Studer has been removed to Ophioglypha by Studer himself; as at present recognized then Pectinura contains 31 species. To Ophiopeza 11 species have been referred, but one of these, *O. custos* Koehler, has been transferred by Koehler himself to Ophioplax, so that there are at present 10 species in the genus. If the old distinction between Pectinura and Ophiopeza is abandoned, the question arises are these 41 species congeneric? By no means; for with one or two exceptions, they fall very naturally into five groups, regardless of the presence or absence of supplementary oral plates and of the equally inconstant character, pores between the basal under arm-plates. Curiously enough the number and arrangement of the tentacle-scales, a feature which in some other groups is so variable that it is of doubtful value even for distinguishing species, is here remarkably constant, and is so obvious as to make a very serviceable character. Of the 41 species under consideration only eight have a single, conspicuous tentacle-scale, while the remainder have two, the outer one overlapping the base of the lowest arm-spine. Of the eight species with the single scale, one is unique in having the whole oral surface, including the oral-shields, covered with a fine granulation; the other seven (with perhaps one exception) form a homogeneous and natural group of deep-water species. Of the 33 species having two tentacle-scales ten, including the type of Pectinura, have the radial shields concealed by the granulation of the disc, and as this appears to be a very constant character the name should be restricted to this group. One of the remaining species is quite unique in its very large, bare, radial shields and wide arm-bases, and as it has twice been made a generic type, it may well stand by itself. For the rest of the 22 species, Ljungman's old name Ophiarachnella is available and should be used. The chief objection to this grouping is that Peter's familiar name Ophiopeza becomes a synonym of Pectinura. It is unfortunate, but in view of the inconstancy of the character upon which the genus is based, this result cannot be avoided.

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[1] Troschel (1879, Sitzungsb. Niederrhein. Gesellsch. Bonn, p. 137) gives a diagnosis of Ophiarachna in which he distinctly says "keine Zahnpapillen" and "Schuppen an den Tentakel-poren." Lütken (1869, Add. Hist. Oph., **3**, p. 74) says, "To fodpapiller" but does not mention tooth-papillae. Lyman (1882, "Challenger" Oph., p. 173) says, "very numerous, close-set tooth-papillae," and "one or two tentacle-scales."

In the examination of the M. C. Z. collection, I have found two undescribed species of this group. I have also found that some of the hitherto recognized species cannot be maintained. I give therefore the following artificial key to the genera which have been under discussion, and a list of the valid species under each genus with artificial keys to the same. The essential synonymy of each genus and species is also included.

Key to the Genera.

Oral shields distinct, not concealed by any granulation.
  Tentacle-scales 2, at least on basal part of arm, with outer overlapping base of lowest arm-spine.

Arm-spines short, rarely (except lowest) exceeding joint (in *Pectinura danbyi* nearly twice as long as joint) more or less closely appressed to arm.
  Radial shields covered by granulation of disc.
    Disc more or less notched at insertion of arm; marginal scales not enlarged or visible through granulation . . *Pectinura*
    Disc not notched at insertion of arms; marginal scales enlarged, conspicuous underneath granulation . . . . *Ophiopezella*
  Radial shields not covered by granulation of disc.
    Radial shields very large; interradial space between two little wider than radial; interbrachial areas (orally) narrower than arm-bases . . . . *Ophiochasma*
    Radial shields small or of moderate size; interradial space between two much wider than radial; interbrachial areas (orally) wider than arm-bases . . . . *Ophiarachnella*
Arm-spines long, 1–3 times as long as joint, more or less flaring; supplementary oral plates present in interbrachial areas . . *Ophiarachna*
Tentacle-scale single, very large (one or two additional may be present on some basal pores); supplementary oral plates rudimentary or wholly wanting . . . . *Bathypectinura*
Oral shields more or less completely concealed by granulation of interbrachial area; tentacle-scale single; arm-spines very short, appressed . . . . *Cryptopelta*

Pectinura.

Forbes, 1842. Trans. Linn. Soc., London, **19**, p. 143.
Type-species, *vestita* Forbes, l. c. Monotypic at the time.

Synonyms: Ophiopeza Peters, 1851. Monatsb. Kön. Ak. Berlin, p. 465. Based on *O. fallax* Peters (l. c.) and supposed to be distinguished by absence of supplementary oral plates. This character having been shown to lack generic value, *O. fallax* is here placed, because of its hidden radial shields, in Pectinura; Ophiopeza thus becomes a pure synonym.

Ophiopsammus Lütken, 1869. Add. Hist. Oph., **3**, p. 37. Based on *Ophiopeza yoldii* Lütken (1859, Add. Hist. Oph., **2**, p. 98) and supposed to be distinguished by absence of supplementary oral plates and concealment of radial shields. The species *O. yoldii* thus belongs in Pectinura as here used, and Ophiopsammus becomes superfluous.

There can be no question as to the type-species of this genus, but unfortunately, owing to the fact that it has not been met with since Forbes secured his single small specimen, there is some room for doubt as to whether the radial shields in that species are covered by the granulation of the disc or not. So far as I can judge from Forbes's description and figure, the radial shields are not to be distinguished, save with difficulty, from the ordinary disc-scales, and like them are covered with granules. Should it be shown hereafter that this interpretation is incorrect, and the radial shields are free from granules, then *P. vestita* belongs in the genus here called Ophiarachnella, which then becomes Pectinura, while Pectinura, as here used, would then take the name Ophiopeza Peters, since the type *O. fallax* is a typical member of this group.

This is a natural and, except for *P. danbyi*, a very homogeneous group of shallow-water forms, confined to the eastern Mediterranean, Indian Ocean, East Indies, Australia, and New Zealand. They are to be distinguished from each other chiefly by the number, length, and appearance of the arm-spines, but the granulation of the disc and the form of the upper and under arm-plates may furnish excellent characters.

Key to the Species of Pectinura.

- Arm-spines blunt, or slightly acute, middle ones not longest.
  - Arm-spines few (4–8).
    - Arm-spines 6–8.
      - Upper arm-plates "somewhat orbicular;" under arm-plates fan-shaped; arm-spines about as long as joint . . . . . . *vestita*
      - Upper arm-plates at first squarish, becoming fan-shaped on outer part of arm; under arm-plates not fan-shaped; arm-spines about $\frac{2}{3}$ joint . . . . *cylindrica*
    - Arm-spines fewer.
      - Arm-spines 5, about $\frac{2}{3}$ joint . . . . *exilis*
      - Arm-spines 4, nearly twice as long as joint . . . . *danbyi*
  - Arm-spines numerous (9–14).
    - Disc granulations coarse (35–200 per sq. mm.); arm-spines $\frac{1}{2}$ joint or longer.
      - Upper arm-plates not twice as wide as long; supplementary oral plates well marked; arm-spines about $\frac{1}{2}$ joint, lowest distinctly longest . . . . *arenosa*
      - Upper arm-plates three times as wide as long or wider; supplementary oral plates often wanting.
        - Size large, disc diameter up to 40 mm.; arms conspicuously spotted with purple; oral shields usually longer than wide; lowest arm-spines largest but not necessarily longest . . . . *maculata*
        - Size smaller, disc diameter seldom up to 25 mm.; arms not at all spotted or marked with purple.
          - Arm-spines subequal; oral shields rather wider than long . . . . *assimilis*
          - Lowest arm-spine decidedly longest; oral shields about as long as wide . . . . *aequalis*
    - Disc granulations very fine (350–500 per sq. mm.); arm-spines scarcely $\frac{1}{2}$ joint . . . . *fallax*
- Arm-spines sharp, middle ones distinctly longest . . . . *yoldii*

Pectinura vestita.

Forbes, 1843. Trans. Linn. Soc. London, **19**, p. 143, pl. 13, figs. 1–7.

Coast of Lycia, Asia Minor, 100 fms.

This species has not been met with since Forbes collected his single specimen, "among corallines" on the coast of Asia Minor, nearly seventy years ago. That specimen was obviously young, having a disc only 2–3 mm. across, and there is room for considerable speculation as to what the adult might reveal as to the real relationship of the species.

Pectinura cylindrica.

Ophiura cylindrica Hutton, 1872. Cat. N. Z. Ech., p. 3.
Ophiopeza cylindrica Farquhar, 1895. Trans. and Proc. N. Z. Inst., **27**, p. 198.

New Zealand. Littoral.

Of three specimens in the M. C. Z. collection, one has five supplementary oral plates, one has four, and one has one. According to Farquhar (l. c.), there are none. Except between the first and second under arm-plates on one arm of one specimen, there are no arm-pores in the M. C. Z. specimens.

Pectinura exilis.

Ophiopeza exilis Koehler, 1905. Oph. "Siboga:" Litt., p. 12, pl. 2, figs. 5, 6, and 8.

Near Tanah, Waigiou, and Kei Islands, D. E. I., 46–222 fms.

It is most unfortunate that figures 5 and 7 of Koehler's plate are transposed, presumably by a slip of the pen. It is stated in the text, on the bottom of the plate (2) and on the explanatory page opposite, that figs. 6–8 are *Ophiopeza exilis*, but a little observation and comparison of the figures and descriptions shows that fig. 7 is *Ophioconis permixta*, while fig. 5, said to be that species, is really *Ophiopeza exilis*.

Pectinura danbyi.

Ophiopeza danbyi Farquhar, 1897. Journ. Linn. Soc. London, **26**, p. 189, pl. 14, figs. 7, 8.

Raoul Island, Kermadecs, N. Z.

The single known specimen of this species is notable for its arm-spines, which show a decided resemblance in number, length, and form, to those of Ophiarachna.

Pectinura arenosa.

Pectinura arenosa Lyman, 1879. Bull. M. C. Z., **6**, p. 48, pl. 14, figs. 392–394. 1882, "Challenger" Oph., p. 15, pl. 23, figs. 10–12.

Off East Moncur Island, Bass Strait, Australia, 38 fms.; Thursday Island, Torres Strait; Point de Galle, Ceylon, 34 fms.

Pectinura maculata.

Ophiarachna maculata Verrill, 1869. Proc. Boston Soc. Nat. Hist., **12**, p. 388.
Pectinura maculata Verrill, 1869. Amer. Journ. Sci., (2) **48**, p. 431 (footnote).

New Zealand. Littoral.

Of three specimens in the M. C. Z. collection, one (disc diameter 41 mm.) has five small but distinct supplementary oral plates; a second (disc diameter 30 mm.) shows one very narrow supplementary oral plate, but the lower surface of the disc is so badly damaged it is impossible to decide positively whether this was the only one present or not; the third (disc diameter 17 mm.) has not the slightest trace of such supplementary plates. Pores seem to be constantly present between the first and second under arm-plates, but in the smallest specimen they can scarcely be seen on two of the arms.

Pectinura assimilis.

Ophiopeza assimilis Bell, 1888. Proc. Zool. Soc. London, p. 282, pl. 16, fig. 5.

Port Jackson, N. S. W.

As this species does not seem to have been met with since its original description was published, it is a pleasure to record a specimen in good condition in the M. C. Z. collection with the disc 25 mm. in diameter. This specimen was acquired by purchase and bears the label "South Australia?" The arms are only about 75 mm. in length and are thus only three times the diameter of the disc. The granulation of the disc is coarser than in Bell's type, as I find only six or seven grains to a millimeter, while he counted nine. The M. C. Z. specimen has apparently never been in alcohol, or at most only for a short time, for in its dry condition the colors are so distinct they must show very nearly the appearance of life. The disc is pale brown, distinctly marked with an irregular star of tawny-brown, each ray of which continues out onto the basal joints of the arm. The lower surface of the disc is yellowish-brown, with the oral shields somewhat darker. The arms, seen from above, are banded with dirty-whitish, the ground color being tawny-brown. Bell's description would indicate a somewhat different coloration for his specimen, which, however, was apparently an alcoholic one. There appears to be a slip of the pen in Bell's description with reference to the measurements. He says the arms are "about four and a half times" the diameter of disc, and then he gives the following measurements: "Diam. of disc 100 (ca.) mm.; length of arms 24 mm." This may mean that the disc is 24 and the arms 100 mm., or possibly the "100" is a misprint for 10 and the "24" a misprint for 42, but in either case the arms would be only four times the disc diameter.

Pectinura aequalis.

Ophiopeza aequalis Lyman, 1880. Anniv. Mem. Boston Soc. Nat. Hist., p. 9, pl. 2, figs. 23–25. 1882, "Challenger" Oph., p. 12, pl. 27, figs. 7–9.

Northeast of New Guinea, 150 fms.; west of Kei Islands, 114 fms.

Pectinura fallax.

Ophiopeza fallax Peters, 1851. Monatsb. Kön. Ak. Berlin, p. 465.

Querimba and Zanzibar, East Africa; Madagascar; Amboina; "Great Ocean." Littoral.

Of eight specimens from Zanzibar in the M. C. Z. collection, one has *six* arms; another has a supplementary oral plate; another has two such plates; the remainder have none.

Pectinura yoldii.

Ophiopeza yoldii Lütken, 1856. Vid. Med., p. 9.
Ophiopsammus yoldii Lütken, 1869. Add. Hist. Oph., **3**, p. 37.
Ophiopeza conjungens Bell, 1884. "Alert" Rept., p. 137.

New South Wales; Queensland; Thursday Island, Torres Strait; off Sumbawa and Waigiou, D. E. I.; "Indian Ocean;" Pandanoa, Philippines; Sumatra. Littoral to 120 (385?) fms.

As the M. C. Z. collection contains a specimen of *P. yoldii* identified by Lyman after examination of the type at Copenhagen, and a specimen of *P. conjungens* from Port Molle, Queensland, identified by Bell, I have been able to satisfy myself that the two names refer to the same species. The form and relative lengths of the arm-spines are very characteristic, while their number varies from 5 to 10 according to the size of the specimen; an adult specimen (disc diameter about 12 mm.) will have 7 or 8 arm-spines on most of the basal joints. Verrill (1899, Trans. Conn. Acad. **10**, p. 373) gives *P. yoldii* as occurring in shallow water in the West Indian region. I have been unable to find any record of this species having been taken anywhere in the western hemisphere. I presume, therefore, that Verrill's statement rests on Lütken's original record; but Lütken does not say that the type-specimen was from the West Indies; he simply says that it was probably West Indian, though the locality on the label (Antillerne) he admits is hypothetical.

Ophiopezella.

Ljungman, 1872. Öfv. Kongl. Vet.-Ak. Förh., **28**, p. 639.
Type *O. spinosa* (*Ophiarachna*) Ljungman, 1867. Öfv. Kongl. Vet.-Ak. Förh., **23**, p. 305. Monotypic at the time.

This genus failed to meet with Lyman's approval, but it has been revived by de Loriol (1893, Rev. Suisse de Zoöl., **1**, p. 392; pl. 13, figs. 1–1e) and really seems entitled to recognition. Ljungman does not designate any type but says the genus is equivalent to "Ophiopeza Ltk., *non* Peters, *nec* Lym.; Ophiarachna Ljn. ex parte." But "Ophiopeza Ltk." (Add. Hist. Oph., **3**, p. 35) was based on two specimens of an ophiuran from Fiji which Lütken considered identical with *Ophiopeza fallax* Peters and also with *Ophiarachna spinosa* Ljungman. Ljungman recognized from Lütken's account that the specimens were not *O. fallax*, but were *O. spinosa*, and de Loriol (l. c.) has confirmed Ljungman's statement that Lütken's Ophiopeza was therefore not the same as Peters's. Moreover *O. spinosa* is the only species in Ophiarachna as used by Ljungman in 1866 to which the diagnosis of Ophiopezella will apply, and it must therefore be the type of the genus. The reasons given by de Loriol (l. c.) for considering Lütken's specimens from Fiji and his own from Amboina distinct from Ljungman's appear very trivial, and I have no doubt that they are *O. spinosa.* There are, however, two species in the genus, and they may be distinguished as follows:

Arm-spines 12–14; color brown	*spinosa*
Arm-spines 9; color yellowish-green	*dubiosa*

Ophiopezella spinosa.

Ophiarachna spinosa Ljungman, 1867. Öfv. Kongl. Vet.-Ak. Förh., **23**, p. 305.
" *Ophiopeza fallax* Peters " Lütken, 1869. Add. Hist. Oph., **3**, p. 35.
Pectinura spinosa Lyman, 1874. Bull. M. C. Z., **3**, p. 221.
" *Ophiopezella spinosa* Ljn." Lyman, 1882. "Challenger" Oph., p. 17.
Ophiopezella Lütkeni de Loriol, 1893. Rev. Suisse de Zool., **1**, p. 392, pl. 13, figs. 1–1 e.

Fua, Tonga Islands; Fiji Islands; Amboina; Society Islands. Littoral.

There are three specimens in the M. C. Z. collection identified by Lyman, and agreeing well with Ljungman's and Lütken's descriptions. They also agree in all essentials with de Loriol's description and figures.

Ophiopezella dubiosa.

Ophiopezella dubiosa de Loriol, 1894. Mem. Soc. Phys. et Hist. Nat. Genève, **32**, pt. 1, no. 3, p. 7, pl. 23, figs. 2–2 f.

Mauritius Littoral.

Ophiochasma.

Grube, 1868. 45th Jahres-Bericht d. Schles. Gesell., p. 45.

Type *O. adspersa* Grube, l. c. (= *Ophiarachna stellata* Ljn.). Monotypic at the time.
Synonym: Ophiopinax Bell, 1884. "Alert" Rept, p. 135. Based on *Pectinura stellata* Lyman, and consequently having the same type as, and being co-extensive with, Grube's genus. Since Lyman (1874, Bull. M. C. Z., **3**, p. 221) had called attention to Grube's proposed genus and shown that its type was identical with *O. stellata*, it seems strange that Bell should have considered a new name necessary; for, though Grube proposed Ophiochasma as a subgenus of Ophiolepis, that does not affect its validity as a generic name (Generic and subgeneric names are . . . from a nomenclatural standpoint . . . of the same value. Int. Code, Art. 6).

Although Lyman regarded this genus as quite superfluous, I agree with Bell that it deserves recognition, for the differentiation of the species on which it is based has gone so much further than in its nearest allies that there is a very distinct gap between it and them.

Ophiochasma stellata.

Ophiarachna stellata Ljungman, 1867. Öfv. Kongl. Vet.-Ak. Förh., **23**, p. 305.
Ophiolepis adspersa Grube, 1868. 45th Jahres-Bericht d. Schles. Gesell., p. 44.
Ophiolepis (*Ophiochasma*) *adspersa* Grube, l. c., p. 45.
Pectinura stellata Lütken, 1869. Add. Hist. Oph., **3**, p. 33.
"*Ophiochasma* (*Ophiolepis*) *adspersum* Grube" Lyman, 1882. "Challenger" Oph., p. 15.
"*Ophiarachnella stellata* Ljn." Lyman, l. c.
Ophiopinax stellatus Bell, 1884. "Alert" Rept., p. 136, pl. 8, fig. C.

Singapore; East Indies; Philippine Islands; Queensland; Torres Straits; Gulf of Siam. Littoral.

Ophiarachnella.

Ljungman, 1872. Öfv. Kongl. Vet.-Ak. Förh., **28**, p. 640.

Type, *O. gorgonia* (*Ophiarachna*) Müller and Troschel, 1842. Sys. Ast., p. 105.

Unfortunately Ljungman failed to designate any type, his only statement being "Pectinura Ltk.; Ophiarachna M. Tr. ex parte." But Lütken (1869, Add. Hist. Oph., **3**, p. 33) had definitely restricted Pectinura to *P. vestita* Forbes, *P. stellata* Ljungman, and *P. gorgonia* Müller and Troschel;[1] and since *P. gorgonia* is the only one of these of which it can be said in any sense "Ophiarachna M. Tr. ex parte," it seems clear that that species must be the type of Ophiarachnella. Lyman evidently considered *P. stellata* the generic type, for he gives as a synonym of *Pectinura stellata*, "*Ophiarachnella stellata* Ljn., Dr. Goës, Oph. Öfv. Kongl. Akad., p. 640, 1871" ("Challenger" Oph., p. 15). But if Ljungman had intended *P. stellata* to be the type-species, he would have written "Ophiarachna Ljn. ex parte" instead of "Ophiarachna M. Tr. ex parte." As already stated it seems desirable to use this generic name for the majority of those ophiurans which have hitherto been called Pectinura. The well-known species *P. gorgonia* M. & T. is not only the type, but also fortunately an excellent example of the group, as the radial shields are of moderate size and very distinct, the tentacle-scales are noticeable for their characteristic form and position, and the arm-spines, though above the average in number, are short and appressed. There appear to be at least fourteen other species which belong in the same genus.

Key to the Species of Ophiarachnella.

Radial shields more or less elongate, of moderate or large size (length commonly much more than $\frac{1}{10}$ diameter of disc), usually not darker in color than disc; usually not more than 3 pairs of arm-pores visible.

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[1] Lütken's statement concerning *P. infernalis* and *P. septemspinosa* of Müller and Troschel is ambiguous, but it is clear he did not consider them typical of Pectinura. Either, however, might be taken as the type of Ophiarachnella if necessary, as they are congeneric with *P. gorgonia*.

- Upper arm-spines not longest and not equalling joint.
  - Arm-spines numerous (8–13).
    - Lowest arm-spine not noticeably longer than others and not equalling joint.
      - Entire disc granulated, except radial shields; arm-pores present . . . . *gorgonia*
      - Some other disc-plates bare, besides radial shields; arm-pores wanting . . . . *infernalis*
    - Lowest arm-spine longest, exceeding joint . . . . *angulata*
  - Arm-spines few (4–7).
    - Arm-spines 4, lowest longest, with tips minutely spinous . . *paucispina*
    - Arm-spines 5–7 (rarely 8), tips not spinous.
      - Radial shields small, widely separated, with 1–3 large, bare plates between; arm-spines rarely 8 . . . . *sphenisci*
      - Radial shields not separated by large bare plates.
        - Arms 8–10 times disc-diameter; arm-spines 6, lowest longest and equalling joint; no arm-pores . . . . *elegans*
        - Arms 4–6 times disc-diameter.
          - Radial shields large and conspicuous; distance between two of a pair less than width of one.
            - Oral shields as wide as long; arm-spines 7; arms slightly carinated . . . . *megaloplax*
            - Oral shields decidedly longer than wide; arm-spines 6; arms strongly carinated . . . . *nitens*
          - Radial shields small; distance between two of a pair greater than width of one.
            - Lowest arm-spine decidedly longest, equalling joint.
              - Arm-spines 5; arm-pores present . . . . . . *stabilis*
              - Arm-spines 6–7; arm-pores wanting . . . . . *petersi*
            - Arm-spines subequal or lowest a trifle larger and rather more than ½ arm-joint.
              - Arm-spines 5; upper arm-plates much wider than long; arm-pores wanting . . . . *capensis*
              - Arm-spines 6–7; upper arm-plates rounded, about as long as wide; arm-pores present . . . . . *semicincta*
- Arm-spines 7–8, upper ones longest, equalling or exceeding joint, lowest much shorter, blunt; under arm-plates much wider than long; 2 pairs of arm-pores present . . . . *honorata*

- Radial shields more or less circular, minute (length commonly much less than $\frac{1}{10}$ diameter of disc), but conspicuous because of their very dark color; more than 4 pairs of arm-pores are usually visible in adult specimens; lowest arm-spines conspicuously longest.
  - Arm-spines 7–10, short, wide, flat, white- (or light-) tipped; color nearly uniformly dark; arms banded with whitish or yellowish, or not at all . . . . *septemspinosa*
  - Arm-spines 7–9, as long as joint, not wide and flat, not white-tipped; color light and dark; arms banded with blackish . . *macracantha*

Ophiarachnella gorgonia.

Ophiarachna gorgonia Müller and Troschel, 1842. Sys. Ast., p. 105.
Pectinura gorgonia Lütken, 1869. Add. Hist. Oph., **3**, p. 33.
Pectinura marmorata Lyman, 1874. Bull. M. C. Z., **3**, p. 222, pl. 5, figs. 1–7.
Pectinura ramsayi Bell, 1888. Proc. Zool. Soc. London, p. 281, pl. 16, figs. 1, 2.
Pectinura intermedia Bell, 1888. Proc. Zool. Soc. London, p. 386.
Pectinura Stearnsii Ives, 1891. Proc. Acad. Nat. Sci. Philadelphia, p. 212, pl. 11, figs. 1–5.
Pectinura venusta de Loriol, 1894. Mem. Soc. Phys. et Hist. Nat. Genève, **32**, pt. 1, no. 3, p. 16, pl. 23, figs. 3–3h.

Natal; Mozambique; Zanzibar; Madagascar; Mauritius; Ceylon; Madras; Pondicherry; Andaman Islands; Nossi-Bé; Tonquin; Pelew Islands; Philippine Islands; southern Japan; Amboina and 15 other stations in Dutch East Indies; Sorong, New Guinea; New Caledonia; Torres Strait; Port Jackson, N. S. W.; Turtle Bay, southern West Australia; Fiji Islands; Gilbert Islands; Samoa. Littoral to 155 fms.

The M. C. Z. collection contains 59 specimens of an ophiuran which, while showing great diversity in size and color, are so alike, or intergrade with each other so completely, in form, proportions, granulation, scaling, arm-plates, oral shields, arm-spines, etc., that I am entirely unable to distinguish more than a single species. This series includes a specimen from Mauritius which answers almost exactly to de Loriol's description and figures of *O. venusta;* Lyman's type and co-types of *O. marmorata* from the Philippines; specimens from Port Jackson, sent by the Australian National Museum, labelled *O. marmorata* (3), *O. ramsayi* (3), and *O. gorgonia* (1); and numerous specimens labelled *O. gorgonia* by Lyman. After a very thorough study of this material, I am unable to satisfy myself that any of the above-named species can be distinguished from *O. gorgonia.* It would be hard to pick out three specimens of Ophiarachnella which look more unlike superficially than a typical *O. gorgonia* var. *viridis* Brock, an *O. marmorata* from the Philippines, and an *O. marmorata* from Port Jackson, the coloration is so strikingly different; and yet when one attempts to separate them in any other way than by color and size it proves to be practically impossible. I am therefore forced to the conclusion that the 59 specimens before me represent a single species, very variable in color and size, and showing more or less diversity in its structural characters. Furthermore, I fail to find any character by which *O. intermedia* Bell is to be distinguished, and I believe the type of *O. stearnsii* Ives is simply an exceptionally large individual of the same species. I am confirmed in this opinion by the fact that such a keen observer as Brock collected only *O. gorgonia* during his stay in the East Indies, not finding any specimens which he could separate as *O. marmorata*, autc., and further by the even more remarkable fact that Koehler, in all of the immense amount of material which has passed through his hands in the past twenty years, including the "Investigator" and "Siboga" collections, has not discovered any specimens of *O. marmorata*, autc. to be distinguished from *O. gorgonia.* It is nevertheless quite possible that in the light of more abundant material it will be shown that some of the species here placed as synonyms of *O. gorgonia* are really entitled to recognition.

Ophiarachnella infernalis.

Ophiarachna infernalis Müller and Troschel, 1842. Sys. Ast., p. 105.
Pectinura infernalis Lütken, 1869. Add. Hist. Oph., **3**, p. 33.
Pectinura similis Koehler, 1905. Oph. "Siboga" Litt., p. 6, pl. 1. figs. 4–6.

Indian Ocean; near Sumatra; Philippines; Queensland; Torres Strait; Pelew Islands; Zanzibar; Sorong, New Guinea; Amboina; a dozen "Siboga" stations in the Dutch East Indies. Littoral to 33 fms.

It is with great hesitation that I disagree with so excellent an authority as M. Koehler concerning the distinctive features of this species, but the 37 specimens in the M. C. Z. collections have convinced me that it is not possible to distinguish the form designated by Koehler (l. c.) as *O. similis* from the ordinary *O. infernalis*. The size, number, and position of the bare plates of the disc and the number of arm-spines show so great diversity in the specimens before me that I find it practically impossible to delimit more than a single species. It is true that none of the specimens studied is a typical *O. similis*, but some of them have 11 arm-spines, and others approach that form in the dorsal plates and radial shields. As the "Siboga" twice took *O. similis* and *O. infernalis* at the same station, there is evidently no geographical or bathymetrical line between the two forms.

Ophiarachnella angulata.

Pectinura angulata Lyman, 1883. Bull. M. C. Z., **10**, p. 232, pl. 3, figs. 7–9.

West Indies, 88–248 fms.; Bahama Bank.

Koehler (Oph. "Siboga" Mer Prof., p. 9) speaks of *O. angulata* as having "une seule écaille tentaculaire"; this is an unaccountable mistake, for Lyman says distinctly "two tentacle-scales" and the specimens before me show the tentacle-scales to be exactly like those of other species of Ophiarachnella.

Ophiarachnella paucispina.

Pectinura paucispina Koehler, 1905. Oph. "Siboga" Litt., p. 4, pl. 1, figs. 13–15.

Strait of Makassar, 20 fms.; off Waigiou, 45 fms.

Ophiarachnella sphenisci.

Pectinura sphenisci Bell, 1894. Proc. Zool. Soc. London, p. 406, pl. 25, figs. 7–9.

Holothuria Bank, N. W. Australia; N. coast of Celebes; near Amboina; off Aru Islands. Littoral to 25 fms.

Koehler (Oph. "Siboga" Litt., p. 10) says that Bell's type was from Macclesfield Bank, while Bell himself says it was from Holothuria Bank. Koehler's very natural mistake is due to the misleading title of Bell's paper.

Ophiarachnella elegans.

Pectinura elegans Bell, 1894. Proc. Zool. Soc. London, p. 406.

Macclesfield Bank, East Indies, 13–35 fms.

Ophiarachnella megaloplax.

Pectinura megaloplax Bell, 1884. "Alert" Rept., p. 134.

Port Molle, Queensland, 14 fms.

Ophiarachnella nitens.

Pectinura nitens Koehler, 1905. Oph. "Siboga" Litt., p. 10, pl. 1, figs. 10–12.

Off Sumbawa, D. E. I., 38 fms.

Ophiarachnella stabilis.

Pectinura stabilis Koehler, 1905. Oph. "Siboga" Litt., p. 5, pl. 1, figs. 7–9.

Paternoster Islands, 7 fms.; off Waigiou, 45 fms.

Ophiarachnella petersi.

Ophiopeza petersi Lyman, 1878. Bull. M. C. Z., **5**, p. 217, pl. 2, figs. 22–24.

Off Cuba, 177 fms.; off Fort Jefferson, Tortugas, Fla., 1½–8 fms.

Aside from the absence of the supplementary oral plate, this species shows well the characters of the genus. So far as the few known specimens show, the supplementary plates are never clearly marked, but in both of the specimens in the M. C. Z. collection the oral shields bulge out on their distal margin into the interbrachial areas, and in one area of the larger specimen (Lyman's type) there is a small supplementary plate.

Ophiarachnella capensis.

Pectinura capensis Bell, 1888. Proc. Zool. Soc. London, p. 282, pl. 16, figs. 3, 4.

Cape of Good Hope.

Ophiarachnella semicincta.

Pectinura semicincta Studer, 1882. Abh. Königl. Ak. Wiss. Berlin, p. 4, pl. 18, figs. 1–1d.

Vicinity of Cape Verde Islands, 38–58 fms.

Ophiarachnella honorata.

Pectinura honorata Koehler, 1904. Oph. "Siboga" Mer Prof., p. 8, pl. 2, figs. 1–3.

Vicinity of Kei Islands, 170 fms.

Ophiarachnella septemspinosa.

Ophiarachna septemspinosa Müller and Troschel, 1842. Sys. Ast., p. 105.
Pectinura septemspinosa Lütken, 1869. Add. Hist. Oph., **3**, p. 33.
Pectinura rigida Lyman, 1874. Bull. M. C. Z., **3**, p. 224.
Ophiarachna armata Troschel, 1879. Sitzungsb. Niederh. Gesellsch. Bonn, p. 137.
Pectinura armata de Loriol, 1894. Mem. Soc. Phys. et Hist. Nat. Genève, **32**, pt. 1, no. 3, p. 13.

Moluccas; Zanzibar; Mauritius; Amboina; Fiji Islands; Ceylon; off Borneo. Littoral to 30 fms.

The specimens in the M. C. Z. collection from Mauritius and Zanzibar, taken in connection with Brock's (Zeit. f. w. Zool., **47**, p. 472) and de Loriol's (l. c.) extended descriptions, and Döderlein's (Zool. Jahrb., Sys., **3**, p. 830) notes, have satisfied me that Döderlein (Semon's Zool. Forsch., **5**, p. 282) is correct in considering *O. armata* too near *O. septemspinosa*, that de Loriol is correct in regarding *O. rigida* as very near *O. armata*, and that Brock is entirely right in placing *O. rigida* as a synonym of *O. septemspinosa*. The three names undoubtedly belong to a single species. Lyman's type of *O. rigida* is a very large, unicolored specimen, but the arm-spines show the characteristic light tips.

Ophiarachnella macracantha, sp. nov.

(Greek *μακρός* = long + *'άκανθα* = spine, in reference to the very long, lowest arm-spine.)

Disc 24 mm. in diameter, pentagonal, distinctly incised at base of each arm; arms about 125 mm. long, nearly 5 mm. wide, and 4 mm. high at base, tapering gradually to the slender tip. Disc (except radial shields) covered with a fairly coarse granulation, about 7 or 8 grains to a millimeter. Radial shields a trifle longer than wide, about 1½ mm. in diameter, very conspicuous. Upper arm-plates about three times as wide as long with fairly straight margins and rounded corners. Under arm-plates at first much wider than long, with very convex distal margin and somewhat concave proximally; further out they gradually become longer than wide. Pairs of pores are very noticeable between each two plates of the first six or eight, and they apparently continue far beyond the middle of the arm. Oral shields rounded with a very indistinct angle inwards, usually wider than long, but one is longer than wide. Side mouth-shields very small, bare. Supplementary oral plates, small and inconspicuous; in one area the supplementary plate is so small and so imperfectly separated from the oral shield it might easily be overlooked. Oral papillae 10–12 on each mouth-angle, flat, rounded, and well-spaced. Mouth-angle terminated by lowest tooth, which is large, flat, and rounded. Arm-spines 8 or sometimes 9, upper and middle ones as long as an arm-joint, somewhat pointed; next to lowest much longer than a joint, bluntly pointed; lowest long and conspicuous, equalling two joints, flat and truncate. Tentacle-scales 2, about equally long and rounded at tip, but outer much wider than inner. Color of disc and arms, above fawn-brown, beneath lighter, and on interbrachial areas more yellowish; radial shields, deep brown; arms with about a dozen annulations, approximately two joints wide, of dark purplish-brown.

In smaller specimens the disc is not distinctly notched at base of arms; the upper arm-plates are only twice as wide as long; there are only 7 arm-spines and the lowest is only equal to 1½ joints; and there are only 6–10 dark annulations on the arms. One specimen has the ground color a much darker brown than the others.

Ponape, Caroline Islands. Rev. A. A. Sturgis coll. Three specimens. The specimens were labelled by Mr. Lyman: "Pectinura septemspinosa? Probably same as unique original at Leyden. Differs 1. Longer arm-spines. 2. Rather finer granulation. 3. Upper arm-plates not broken." Since Mr. Lyman wrote that label *O. septemspinosa* has been found abundantly at Amboina, Ceylon, and Mauritius, and has been fully described and its variations discussed by Brock (l. c.), Döderlein (l. c.), and de Loriol (l. c.). In the light of our present knowledge, it seems impossible to consider these specimens from the Caroline Islands as belonging to *O. septemspinosa* or any other described species.

Ophiarachna.

Müller and Troschel, 1842. Sys. Ast., p. xiii, 84, 104.

Type, *O. incrassata* Müller and Troschel, l. c. Selected by Lütken, 1869. Add. Hist. Oph., 3, p. 33.

It is hard to understand why Lütken and Lyman should have considered this genus closely allied to Ophiocoma. If one ignores the length of the arm-spines, it is not easy to point out a single character by which Ophiarachna can be separated from Pectinura. I am unable to see that the *position* of the spines on the side arm-plate is essentially different even in Ophiocoma from what it is in Pectinura; it seems to be simply a difference in the size of the spines. Lyman ("Challenger" Oph., p. 173) has pointed out the very important difference between Ophiarachna and Ophiocoma, in the structure of the "peristomial plate," but he fails to note that Ophiarachna strongly resembles Ophiopeza and the other Ophiodermatidae in that feature. Lyman says that in all other particulars the skeleton resembles that of Ophiocoma, but the same is true of the Ophiodermatidae in general, so that it is no argument in support of associating Ophiarachna with Ophicoma.

As limited by Lütken and in the sense in which the name is now universally used Ophiarachna includes four species.

Key to the Species of Ophiarachna.

Radial shields concealed by granulation of disc.
  Arm-spines 4, very rarely 5, on a few basal joints; colors chiefly yellow or greenish . . . . *incrassata*
  Arm-spines 5–7, rarely 4; colors chiefly brown of some dark shade.

Oral shields wider than long; disc brown and yellowish; arms annulated . . . . *affinis*
Oral shields longer than wide; disc uniform, deep brown; arms not annulated . . . . *mauritiensis*
Radial shields bare; disc brown, more or less variegated with yellow; arm-spines 4–5 . . . . *robillardi*

Ophiarachna incrassata.

Ophiura incrassata Lamarck, 1816. Anim. sans Vert., **2**, p. 542.
Ophiarachna incrassata Müller and Troschel, 1842. Sys. Ast., p. 104.

Java; Pelew Islands; Philippines; New Britain; Amboina; Timor; half a dozen "Siboga" stations in D. E. I.; "Sea of Bengal;" Ceylon; Zanzibar; Darros Island; "intertropical Australia." Littoral to 20 fms.

A specimen in the M. C. Z. collection measures 56 mm. across the disc and is the largest simple-armed ophiuran of which I can find any record.

Ophiarachna affinis.

Ophiarachna affinis Lütken, 1869. Add. Hist. Oph., **3**, p. 33.
Ophiarachna clavigera Brock, 1888. Zeits. f. w. Zool., **47**, p. 47.

Fiji Islands; Samoa; Amboina; Fernando Veloso, Mozambique. Littoral.

Both de Loriol (Rev. Suisse de Zool., **1**, p. 411) and Koehler (Mem. Soc. Zool. France, **17**, p. 76) are agreed that *O. clavigera* Brock is a synonym of *O. affinis*, and I see no reason to doubt their decision. It does seem doubtful, however, whether the specimen recorded by Koehler (Bull. Sci. France et Belgique, **41**, p. 330) from Fernando Veloso, with only 3–4 arm-spines, is really *O. affinis*. The locality and the very small number of arm-spines cause one to be suspicious.

Ophiarachna mauritiensis.

Ophiarachna mauritiensis de Loriol, 1894. Mem. Soc. Phys. et Hist. Nat. Genève, **32**, pt. 1, no. 3, p. 32, pl. 24, figs. 1–1e.

Mauritius.

Ophiarachna robillardi.

Ophiarachna robillardi de Loriol, 1894. Mem. Soc. Phys. et Hist. Nat. Genève, **32**, pt. 1, no. 3, p. 31, pl. 23, figs. 5–5e.

Mauritius.

Bathypectinura, gen. nov.

(Greek *βαθύς* = deep + *pectinura*, in reference to the characteristic habitat of the group.)

Disc, excepting radial shields, covered above and below by granules, which more or less fully conceal the underlying layer of scales. Radial shields of moderate or small size, bare, but not conspicuous. Oral shields conspicuous, but supplementary oral plates rudimentary or wholly wanting. Arm-spines relatively few (3–6) and short. Tentacle-scale single and very large; on basal pores of arm supplementary scales of small size and irregular position are occasionally present. No pores between under arm-plates. Genital slits two in each interbrachial area.

Type-species, *B. lacertosa* (*Pectinura*) Lyman, 1883. Bull. M. C. Z., **10**, p. 231, pl. 3, figs. 4–6.

This is a very natural group of large, deep-water ophiurans, all but one of which have been referred hitherto to the genus Pectinura in spite of the rudimentary condition of the supplementary oral plates. The *Ophiopeza reducta* of Koehler (1907, Bull. Sci. France et Belgique, **41**, p. 283) differs from the other species not only in its elongated radial shields, but also in its coloration, for while they are unicolor (whitish in alcohol or dry), Koehler's single specimen of *O. reducta* shows traces of a variegated disc and annulated arms. Koehler very naturally considers that this coloration would indicate a shallow-water habitat, and if such is the case, *O. reducta* would differ markedly from the other species of the genus in that particular. However, its structural peculiarities appear to necessitate its being placed in this genus, at least until we have further light on its distribution and variability.

Key to the Species of Bathypectinura.

- Arm-spines 3 or 4.
  - Radial shields not twice as long as wide; under arm-plates not quadrilateral, the first one wider than long.
    - Oral shields wider than long; arm-spines longer than ½ arm-joint.
      - Disc including more than 4 basal arm-joints; upper arm-plates highly arched so that arm-spines appear low down on side of arm . . . . *lacertosa*
      - Disc including not more than 3 basal arm-joints; upper arm-plates not highly arched so that arm-spines do not appear low down on side of arm . . . . *elata*
    - Oral shields longer than wide; arm-spines shorter than ½ arm-joint; disc including more than 4 basal arm-joints . . . . *heros*
  - Radial shields 3 times as long as wide; under arm-plates quadrilateral, the first one longer than wide . . . . *reducta*
- Arm-spines 5 or 6.
  - Lowest arm-spine longest, equal to arm-joint . . . . *modesta*
  - Arm-spines subequal, about ½ as long as arm-joint.
    - Interbrachial areas (orally) densely granulated . . . . *conspicua*
    - Interbrachial areas with many bare plates, surrounded by granules *tessellata*

Bathypectinura lacertosa.

Pectinura lacertosa Lyman, 1883. Bull. M. C. Z., **10**, p. 231, pl. 3, figs. 4–6.

Off Grenada, 159 fms.

Bathypectinura elata.

Pectinura elata Koehler, 1906. Mem. Soc. Zool. France, **19**, p. 7, pl. 1, figs. 1–3; 1907, "Travailleur" et "Talisman" Oph., p. 249, pl. 18, figs. 1–3.

Southwest of Canary Islands, 1292–1399 fms.

Bathypectinura heros.

Pectinura heros Lyman, 1879. Bull. M. C. Z., **6**, p. 48, pl. 14, figs. 389–391. 1882, "Challenger" Oph., p. 16, pl. 23, figs. 7–9.

Off Aru Islands, 800 fms.; off Laccadive Islands, 865–880 fms.; Bali Sea, northeast of Java, 538 fms.; Strait of Makassar, 1116 fms.

Bathypectinura reducta.

Ophiopeza reducta Koehler, 1907. Bull. Sci. France et Belgique, **41**, p. 283, pl. 10, figs. 1, 2.

Locality and depth unknown.

Bathypectinura modesta.

Pectinura modesta Koehler, 1904. Oph. "Siboga" Mer Prof., p. 7, pl. 2, figs. 4–6.

Northeast of Java, 183 fms.

Bathypectinura conspicua.

Pectinura conspicua Koehler, 1897. Ann. Sci. Nat. Zool., (8) **4**, p. 322, pl. 6, figs. 36, 37; Oph. "Siboga" Mer Prof., pl. 1.

Gulf of Bengal, 410 fms.; off Sumbawa, Flores and Celebes, D. E. I., 300–1116 fms.

Bathypectinura tessellata.

Pectinura tessellata Lyman, 1883. Bull. M. C. Z., **10**, p. 230, pl. 3, figs. 1–3.

Off Santa Cruz, Danish West Indies, 451 fms.

Cryptopelta, gen. nov.

(Greek κρυπτός = hidden + πέλτη = shield, in reference to the covering of the oral shields by granules.)

Disc, including radial shields, interbrachial areas, oral shields (except rarely the central part), adoral plates, and angles of jaws, entirely covered with a close, fine granulation, which entirely conceals the underlying scales and even extends onto the bases of the arms. Arm-spines about 7, short and appressed. Tentacle-scale single. Teeth few, narrow, acute. Oral papillae numerous (16–18 on each jaw), distal ones wide and blunt, proximal narrow and sharp. No pores between basal under arm-plates. Genital slits 2 in each interbrachial area.

Type, *C. aster* (*Ophiopeza*) Lyman, 1882. "Challenger" Oph., p. 12, pl. 21, figs. 16–18.

The discovery in the M. C. Z. collection of a new ophiuran, closely related to *Ophiopeza aster* Lyman, has served to emphasize the peculiarities of that species. The two seem to form a very distinct group, the nearest ally of which is probably to be found in the genus Pectinura or possibly in the peculiar *Bathypectinura reducta*. They may be distinguished from each other as follows: —

Upper arm-plates, especially first one, much wider than long, widely separated on last 12–15 arm-joints; arm-spines 6–9, not half as long as joint, blunt, upper much shorter than lowest two	*aster*
Upper arm-plates about as long as wide, first one nearly circular, in contact to very tip of arm; arm-spines 7, half as long as joint, sharp, subequal	*granulifera*

Cryptopelta aster.

Ophiopeza aster Lyman, 1879. Bull. M. C. Z., **6**, p. 50, pl. 14, figs. 395-397. 1882, "Challenger" Oph., p. 12, pl. 21, figs. 16–18.

Off Cape of Good Hope, 150 fms.; Paternoster Islands, 7 fms.; Sulu Islands, 9–13 fms.

Koehler's statement (Oph. "Siboga" Litt., p. 13) that the "Challenger" specimens were taken near New Guinea is an unaccountable slip, as in both of Lyman's papers the station is given as 142, which was 35° 4′ S. × 18° 37′ E. Lyman says (l. c.) there are six arm-spines, but the M. C. Z. specimen has seven, and Koehler (l. c.) found seven, eight, and in one specimen nine.

Cryptopelta granulifera, sp. nov.

(Latin *granulum* = a little grain + *fero* = bear, in reference to the unusual granulation of the oral surface.)

Disc pentagonal, 7 mm. in diameter, closely covered by a fine granulation, which, however, is coarser and more distinct than in *aster*, with about 15–20 grains per millimeter. Arms about 25 mm. long, a trifle more than a millimeter broad and less than a millimeter high, distinctly flattened. There is no notch in the disc at the base of the arm, but on the contrary the granulation of the disc conceals the basal upper arm-plates. First (visible) upper arm-plate nearly circular; others about as long as wide, with straight proximal, diverging lateral, and convex distal margins. Interbrachial areas orally completely covered with disc granulation to the very bases of the oral papillae, except that the oral shield containing the madrepore is partially bare. Oral papillae 18–22 on each jaw; penultimate widest, almost square; proximal very acute. Teeth 3–4, narrow and very sharp. Under arm-plates squarish, or further out more pentagonal, with rounded corners; first one much longer than wide and very narrow; succeeding ones broader; 7–12 about as wide as long. Arm-spines 7 at base of arm, subequal, acute, half as long as joint. Tentacle-scale single, somewhat longer than wide, rounded. Genital slits conspicuous, 2 in each interbrachial area. Color of disc very pale fawn-brown, becoming yellowish below; arms whitish, with 3–5 broad bands (including 2–5 joints) of dull purplish-brown; these bands are not visible on the lower surface.

Mauritius. N. Pike, Collector. One specimen.

This interesting specimen was received at the Museum in 1875 and bears the label "Ophiopeza fallax." At first sight it might be mistaken for a young individual of that species, but examination of the oral surface with a lens soon shows how very different it is. Its close resemblance to *Ophiopeza aster* Lyman is obscured by its very different coloration and much more flattened arms.

ASTROPHYTIDAE.

Conocladus, gen. nov.

(Greek *κῶνος* = cone + *κλάδος* = branch, in reference to the branching arms and the large conical tubercles.)

Disc divided into five radiating wedges by the pairs of radial shields and covered, together with the upper surface of the arms, by an uneven pavement of polygonal, flat granules of very diverse sizes, among which large, conical, or rounded tubercles are irregularly scattered. (In young individuals these tubercles are few and there may be only a single one on each "radiating wedge.") Arms branching dichotomously, with four or more divisions; the distance of the first division from the margin of the disc is about equal to the diameter of the disc. Under surface of disc and arms covered with a pavement of small, rounded granules. Tentacle-scales (or arm-spines) about 4, short, peg-like, and somewhat flattened, terminating in 3–5 minute, glassy points. Mouth-angles with a group of flat, pointed teeth, deep in the mouth, and a few scattered, spiniform, oral papillae along the margins.

In the structure of the disc, though not in its ornamentation, this remarkable genus resembles Astroporpa more nearly than it does any of the Astrophytidae, but in the branching of the arms it is intermediate between Trichaster and Gorgonocephalus.

Conocladus oxyconus, sp. nov.

(Greek, *ὀξύς* = sharp + *κῶνος* = cone, in reference to the pointed form of the cones on the disc.) Plate.

Diameter of disc 18 mm. Length of arm about 60 mm.; width of arm near disc 6 mm.; height of arm near disc 4 mm. Radiating wedges of disc separated from each other by 5 deep, very narrow grooves with vertical sides, which meet at centre of disc in a hole or pit scarcely a millimeter in diameter but fully 2 millimeters deep. Each wedge is covered with plates, grains, or granules, usually flat and smooth, sometimes rounded, of very diverse sizes, the largest about a millimeter across. Among these are scattered 5–7 conical tubercles, about 2 mm. high and 1.5 mm. in diameter at the base. The tubercles are smooth at the base but are more or less rough with pits and ridges at the tip. They have no regular arrangement, but one is at the innermost angle of the wedge. The pavement of plates and granules extends out on the arm so that there is no line of division between the latter and the disc. The large tubercles tend to form a single series on the upper surface of each arm, becoming gradually smaller as they approach the second fork, beyond which they are rarely found. There are about 4 on the basal segment of the arm and about 5 on each of the branches before the first fork. The arms branch about 6 times, the first division being about 20 mm. from the disc; the resulting branches are sometimes equal and sometimes strikingly unequal. Beyond the second or third fork, the branchlets are very slender and are covered by alternating paired half-circles of granules and glassy hooklets, so commonly found in the Astrophytidae. The oral surface of disc and arms is covered with small, roundish, flat granules, most numerous on the mouth-angles and bases of the arms. The tentacle pores are small and indistinct; the first pair (not counting those between the mouth-angles) are between the first and second arm-joints and have no protecting tentacle-scales. Each succeeding pore is more or less concealed by a slight ridge on its adoral side, which carries 4 (rarely 3 or 5) short, slightly curved, peg-like spines or scales. Each spine is somewhat flattened and is a trifle widened at the tip where its margin divides into 3–5 little glassy spinelets. Each mouth-angle carries deep in the mouth a cluster of about half a dozen flat, pointed teeth, and along each side of the mouth-slit are 3–5 spiniform oral papillae. The genital slits are prominent, about 2 mm. long. The madrepore plate is single and rather conspicuous, about 2 mm. across. The color (dry) is almost uniformly whitish, becoming more yellowish about the mouth and on the under side of the arms. In a young individual (fig. 3), with the disc 8 mm. across, each radiating wedge carries only a single conical tubercle. The tubercles on the arms are arranged in an almost perfect, single series. All of the tubercles are furrowed and ridged over their entire surface. The arms branch only 3 or 4 times. The color is very light brownish, darkest underneath.

Of this remarkable species the M. C. Z. collection contains three dry specimens. One of these (fig. 3) has been in the collection for many years and bears only the label "Astrophyton australe? Young"; there is no indication of locality. The other two were received in exchange from the Australian Museum and are labelled, "Gorgonocephalus australis Verril??? Off Port Jackson, 40–50 fms." The character of the disc shows that these specimens are not Gorgonocephalus, but in view of the branching arms it is not altogether strange that they have been referred to that genus. Both of the specimens from Port Jackson were closely embracing the branches of a sponge.

ECHINOIDEA.

CIDARIDAE.

Porocidaris elegans.

Porocidaris elegans A. Agassiz, 1879. Proc. Amer. Acad., **14**, p. 198.

A fine series of ten specimens of this species, from off Port Jackson, N. S. W. 250–800 fms., is in the Museum collection. They are remarkably uniform in their yellowish-brown coloration and in the characters of test, spines, and pedicellariae. Superficially they look very different from the specimens taken by the "Challenger" at nearly the same place (Station 164 a), which are dull reddish in color and have much stouter spines. I do not find, however, any satisfactory specific differences. The Museum now possesses one of the specimens of this species collected by the "Siboga" near Celebes, and one taken by the "Valdivia" near Sumatra, and there seems to be no important difference between them. In size and form, and in length and slenderness of the primary spines, the "Siboga" specimen is remarkably similar to the series of ten from Port Jackson, but it lacks entirely the yellowish-brown coloration. The test is pale dull reddish, and the spines, even secondaries and miliaries, are pure white.

ECHINOTHURIDAE.

Asthenosoma thetidis, sp. nov.

Test rather firm, though greatly flattened in the preserved specimens. Coronal plates, moderately high; in interambulacra, about 20 on actinal side and 25 abactinally, in a specimen 180 mm. in diameter; in ambulacra there are only about 28 actinally and 42 abactinally. Primordial interambulacral plate at peristome very distinct. Ambulacra wide, nearly three-fourths as wide at ambitus as interambulacra. Poriferous areas rather narrow, clearly defined. Primary tubercles abactinally, very few (100–125) and irregularly scattered; actinally, each interambulacral plate carries one or two, but they are arranged in such a way that there are three columns of big tubercles on each side of an interambulacrum, the median area being nearly free from primaries; most of the actinal ambulacral plates, except those nearest the actinostome, carry a large tubercle near the inner end and a smaller one near the interradial end, so that there are four more or less irregular columns of tubercles in each ambulacrum, of which the two median are decidedly the most conspicuous. Secondary and miliary tubercles are comparatively few, and the inner ends of the interambulacral plates, and both ends of the ambulacral plates abactinally, are entirely free from them, so that there are 20 conspicuous, bare areas radiating from the abactinal system to the ambitus. Abactinal system about .17 of the diameter of test; genital plates large (7 × 7 mm.), roughly triangular, usually not in contact with oculars, but separating the uppermost two pairs of interambulacral plates; genital openings very large, 3 to 4 mm. in diameter, but confined within the plate; ocular plates rather small, about 3 mm. wide by 2½ high; anal plates small, widely separated, about 60 in number. Actinostome about .23 of test-diameter, with 13 or 14 concentric series of ambulacral plates, which diminish so rapidly in size near the teeth that opposite each tooth is a bare, wedge-shaped area 3 mm. wide at base (against the tooth) and about 8 mm. long. Primary spines relatively short, only 15–20 mm. long, even on the actinal surface, where they are tipped with a slender white hoof 3–4 mm. long. Secondary and miliary spines very slender. Pedicellariae not peculiar, very similar to those of *A. owstoni* (Mortens.); both tridentate and triphyllous are abundant. Color of test deep brown in alcoholic specimens, becoming bright brown when dry; spines, green abactinally, but greenish-brown on the actinal surface; hoofs of the primaries, white.

Off Botany Bay, New South Wales, 80 fms.

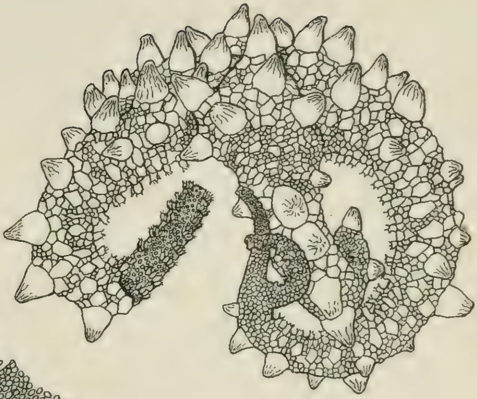
An excellent series of ten specimens of this interesting echinothurid are in the M. C. Z. collection. They were received in exchange from the Australian Museum, and are labelled "Phormosoma hoplacantha." This is undoubtedly the species to which Mr. Waite refers in his introduction to the reports on the collections of the "Thetis," when he says that "in eighty fathoms off Botany Bay, between two and three hundred examples of the rare echinoderm *Phormosoma hoplacantha* Wy. Thompson, were hauled on board. This find was specially interesting as the animal had previously been taken only by the 'Challenger' at the minimum depth of 410 fathoms."

The relationship of *A. thetidis*, however, is not with the deep-water species like *A. hoplacantha*, but with the shallow-water forms like *Asthenosoma owstoni* (Mortens.), to which it seems to be nearly allied. It may be distinguished from that Japanese species, however, by the larger and less numerous primary tubercles, the much higher actinal coronal plates, the more regular arrangement of the actinal interambulacral tubercles, the much wider ambulacra, and the very different color. I take pleasure in associating with this interesting species the name of the vessel to which we owe its discovery.

EXPLANATION OF PLATE.

Conocladus oxyconus.

Fig. 1. Adult specimen, somewhat contracted, seen from the side. × 2.
Fig. 2. Part of oral surface, showing mouth angle, genital slits, etc. × $2\frac{1}{2}$.
Fig. 3. Young specimen, seen from above. × $2\frac{1}{2}$.



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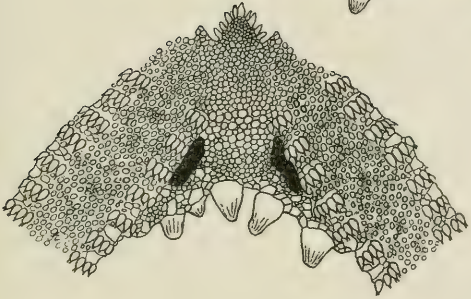

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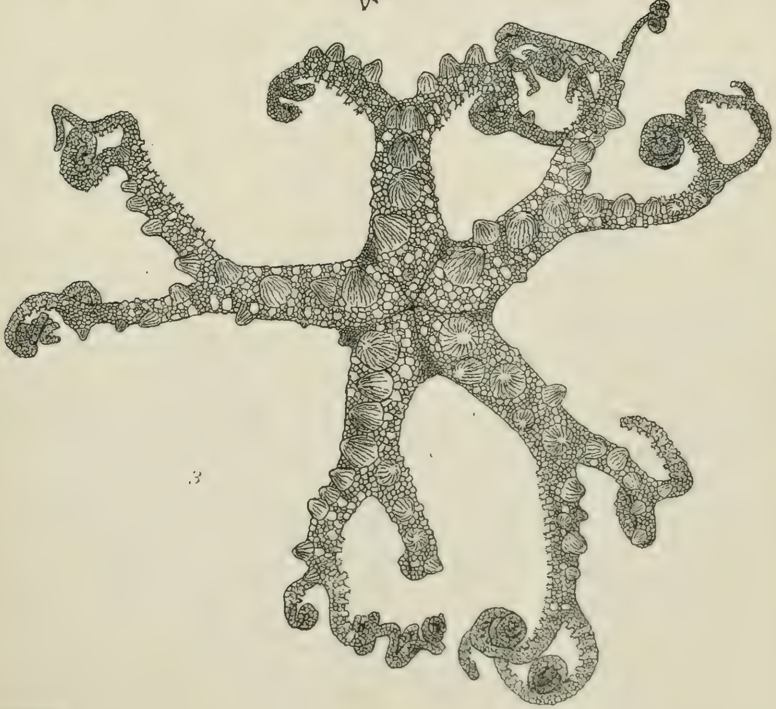

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B. Meisel photo., lith.

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AT HARVARD COLLEGE.
VOL. LII. No. 8.

DESCRIPTIONS OF NEW BIRDS FROM CENTRAL CHINA

BY JOHN E. THAYER AND OUTRAM BANGS.

CAMBRIDGE, MASS., U.S.A.:
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MAY, 1909.

No. 8. — *Descriptions of New Birds from Central China.* By JOHN E. THAYER and OUTRAM BANGS.

The birds here described as new are from the province of Hupeh, Central China. They are part of the first instalment of a series of bird skins collected by Mr. Walter R. Zappey. The senior author, recognizing that zoölogical specimens from Central and Western China are very imperfectly represented in American museums, took advantage of the opportunity offered by the Arnold Arboretum botanical exploration in charge of the well known English collector, Mr. E. H. Wilson, and engaged Mr. Zappey to accompany the Wilson expedition. The series thus far received consists of more than 3,000 skins, all in excellent condition. Later, when all the material has been studied, we shall publish a complete list of the birds observed, with data, and the itinerary, and field notes of the collector.

Collocalia fusciphaga capnitis, subsp. nov.

Type. — Coll. M. C. Z., No. 50,013, adult ♂, Wan-tas-shan, Hupeh, China, June 5, 1907. W. R. Zappey.

Characters. — Similar to *C. fusciphaga vestita* (Lesson) from Sumatra and the southern Malay Peninsula but larger (larger even than *C. fusciphaga elaphra* Oberholser which is the largest of the group); paler above and greenish instead of brownish black; rump rather paler than back (rump and back are concolor in *C. f. vestita*); underparts more grayish, less brownish, and with more evident blackish shaft streaks.

Measurements of the type, wing, 123; tail, 56; tarsus, 10; culmen, 5.2.

Collocalia inopina, sp. nov.

Type. — Coll. M. C. Z., No. 50,014, adult ♂, Ma-fu-ling, Hupeh, China, 5,000 feet, June 1, 1907. W. R. Zappey.

Characters. — Most closely allied to *C. lowi* (Sharpe) from northern Borneo, Anambas Islands, etc., but slightly larger, and browner in general coloration. The back especially much browner; rump, pale, contrasting with back (in *C. lowi* the rump is but little paler than the back). Underparts with the pronounced dark shaft lines as in *C. lowi*.

Measurements of the type, wing, 134; tail, 56; tarsus, 12; culmen, 5.5.

Remarks. — As Collocalia has not been recorded from Central China, it is noteworthy that Zappey took two distinct species in the province of Hupeh, and that both are well-defined new forms. When in Washington recently the junior author had the great advantage of being able, in company with Mr. Oberholser, to compare these birds with ample material, and at a time when the specific differences of this difficult group were still vivid to Mr. Oberholser.

Turdus cardis lateus, subsp. nov.

Type. — Coll. M. C. Z., No. 50,015, adult ♂, I-chang, Hupeh, China, April 27, 1907. W. R. Zappey.

Characters. — Similar to true *Turdus cardis* Temminck of Japan, but differing in the head being slaty, instead of brownish, black; the black of head sharply defined against the dark gray of the neck and back (in true *T. cardis* the back is usually much mottled with black, often nearly wholly black, and the line between the black of the head and the gray of the back is never sharply defined); black spots on breast and abdomen much smaller and more sparse; sides wholly dark gray; under wing coverts darker and more uniform (even in the young) rufous.

Measurements of the type, wing, 119; tail, 77.5; tarsus, 31.5; culmen, 21.

Remarks. — True *Turdus cardis* of Japan is supposed to winter in southeastern China, but so far as we know no thrush allied to *T. cardis* has been recorded as breeding in or near central China. Mr. Zappey, however, took specimens including young in nestling plumage at I-chang in April, June, and July, thus establishing the fact, that a race of *Turdus cardis* does breed in the region of the upper Yangtsz.

Parus major artatus, subsp. nov.

Type. — Coll. M. C. Z., No. 50,000, adult ♂, I-chang, Hupeh, China, March 1, 1907. W. R. Zappey.

Characters. — Similar to *Parus major minor* (Temminck and Schlegel) of Japan, but with underparts on each side of central black streak, pinkish or buffy white (in *P. m. minor* yellowish white); back duller, less greenish-yellow, more grayish, the rump wholly gray. Of about the same size as *P. m. minor.*

Measurements of the type, wing, 69.5; tail, 58; tarsus, 18; culmen, 10.5.

Remarks. — As regards the other two allied subspecies: *P. m. tibetanus* Hartert is said to have much more white in the tail than *P. m. minor*, which is not the case with the I-chang birds; and *P. m. commixtus* Swinhoe, from Amoy and southern China, is smaller.

Nucifraga hemispila macella, subsp. nov.

Type. — Coll. M. C. Z., No. 50,012, adult ♂, Hsien-shan-hsien, Hupeh, China, 7,000 feet, December 11, 1907. W. R. Zappey.

Characters. — Very similar to the Himalayan, true *N. hemispila* Vigors, but smaller, with a shorter and thicker bill; and more heavily spotted, above and below, with larger spots of white.

Measurements of the type, wing, 126; tail, 137; tarsus, 38; culmen, 37.5.

Cyornis tickelliae glaucicomans, subsp. nov.

Type. — Coll. M. C. Z., No. 50,003, adult ♂, Tan-swio-Yah, Hupeh, China, May 7, 1907. W. R. Zappey.

Characters. — Similar to true *Cyornis tickelliae* Blyth from India, but much larger; back much duller, more grayish blue; bright blue band across forehead sharply defined against dull grayish blue of head; underparts with the abdomen white and the chest buffy, strongly contrasted, the former never washed with buffy.

Measurements of the type, wing, 80; tail, 57; tarsus, 18; culmen, 12.

Niltava lychnis, sp. nov.

Type. — Coll. M. C. Z., 50,001, adult ♂, Pao-tung, Hupeh, China, May 19, 1907. W. R. Zappey.

Characters. — Most nearly like *N. sundara* Hodgs., from the Himalayas, but much larger; differing in color in having the shoulders purple like the back (not bright blue); the band on side of neck, bright ultramarine blue; underparts paler, — pale rufous tawny on chest, shading off to orange buff on the middle of abdomen and under tail coverts.

Measurements of the type, wing, 91; tail, 65.5; tarsus, 21; culmen, 11.5.

Cyanoptila cumatilis, sp. nov.

Type. — Coll. M. C. Z., 50,004, adult ♂, Ma-fu-ling, Hupeh, China, 5,500 feet, May 14, 1907. W. R. Zappey.

Characters. — Similar in colon pattern to *Cyanoptila bella* (Hay) from Japan and Corea, but the colors of ♂ very different. Forehead and crown bright cobalt blue, as are also the shoulders; rest of upper parts verditer blue, with no black shaft lines on back; throat and chest dull dark verditer blue separated from the white of abdomen and under tail coverts by a blackish line. Adult female very similar to that of *C. bella,* and differing only in having less white in the throat.

Measurements of the type, wing, 94; tail, 61.5; tarsus, 17; culmen, 12.5.

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REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XVIII.

AMPHIPODA.

Von R. Woltereck.

With Eight Plates.

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No. 9. — *Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific in charge of* Alexander Agassiz, *by the U. S. Fish Commission Steamer "Albatross" from October, 1904, to March, 1905, Lieutenant-Commander* L. M. Garrett, *U. S. N., Commanding.*

XVIII.

AMPHIPODA.

Die Hyperiidea gammaroidea.[1] Von R. Woltereck.

1. Teil: Tribus "Primitiva" dieser Unterordnung.

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Einleitung.

Die beiden grossen Unterordnungen der Amphipoden: die Gammariden oder Crevettinen und die Hyperiden werden durch einige eigentümliche, pelagische Formen verbunden, welche nicht nur durch die in der Regel gammaridenähnliche Körperform, den kleinen, nicht abgesetzten Kopf und das ebenfalls kleine Auge an die ursprünglichere

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[1] Zugleich eine weitere Mitteilung über die Ergebnisse der Valdivia- und Gauss-Expedition. (Vergl. Zool. Anzeiger, 1902–08.)

Organisation der bodenbewohnenden Amphipoden erinnern, sondern welche auch, zum Teil wenigstens, im Bau ihrer Mundgliedmassen ursprünglichere Züge aufweisen als die eigentlichen Hyperiden, die *Hyperiidea genuina.*

Als die wichtigste Veränderung der Hyperiden im Verhältniss zu den Gammariden haben wir die Umgestaltung anzusehen, welche aus den (bis auf das gemeinsame Basalglied) *paarigen* Kieferfüssen (Maxillipeden) der Gammariden die stark reduzierte Doppelplatte der Hyperiden-"Unterlippe" gemacht hat (s. Fig. 1–5).

Dieser Unterschied ist in der That der einzige völlig durchgreifende zwischen beiden Unterordnungen, und es ist durchaus berechtigt, wenn man diejenigen Amphipoden, welche in diesem Punkte — und zugleich in Bezug auf Kopf und Auge, meistens auch in ihrem Habitus — eine Mittelstellung zwischen beiden Typen einnehmen (Fig. 4), zu einer besonderen intermediären Unterordnung, den *Hyperiidea gammaroidea* (Milne-Edwards) vereinigt.

Jedenfalls trägt eine solche Anordnung viel dazu bei, die verwickelte Amphipoden-Systematik übersichtlicher und vor allem natürlicher zu machen.

In dieser intermediären Unterordnung müssen vorläufig auch diejenigen Formen belassen werden, bei welchen zwar die Verschmelzung der Unterlippe weiter fortgeschritten ist, die aber durch ihren sonstigen Bau nahe Beziehungen zu den "echten" *Hyperiidea gammaroidea* (d. h. denjenigen mit paariger Innenlade der Unterlippe) verraten. Es sind das die Sciniden und Vibiliden.

Sie haben mit jenen "echten" Uebergangsformen nicht nur den kleinen, nicht abgesetzten Kopf und das kleine Auge gemeinsam, sondern sie sind auch, wie wir sehen werden, durch die von Stebbing (1904) entdeckte Gattung *Archaeoscina* auf das engste mit den Mimonectiden und Lanceoliden verbunden. Die Vibiliden und weiterhin die Sciniden waren es auch, für welche die intermediäre Sonderstellung (von Milne-Edwards, Chun, Garbowski) zuerst ausgesprochen wurde, während die Lanceoliden und Mimonectiden bisher allzu unbekannt geblieben waren, um verwertet zu werden. Für die letzteren liess sich ein näherer Zusammenhang mit gammaridenähnlichen Formen auch durchaus nicht vermuten, solange man nur die bizarr aufgeblähten Formen kannte, welche Bovallius beschrieben hat. Erst durch die Funde der Valdivia- und Gauss-Expedition wurde die Zusammengehörigkeit jener seltsamen Kugelgeschöpfe mit den Sciniden auf der einen Seite (durch *Sphaeromimonectes*) und den Lanceoliden auf der anderen Seite (durch *Micromimonectes*) deutlich; und nach den im Folgenden neu zu beschreibenden weiteren Zwischenformen erscheint es sicher gestellt, dass es ein förmliches, aus grossenteils recht eigenartigen und seltenen Erscheinungen zusammengesetztes "Zwischenreich" zwischen Gammariden und Hyperiden giebt.

Die Angehörigen dieses Zwischenreichs der *Hyperiidea gammaroidea* sondern sich nun in zwei recht scharf geschiedene Gruppen. Tribus I. *Primitiva* umfasst die Formen mit *geteilten* Kauladen der Unterlippe (Fig. 4), es sind 10 Formen, welche zum Teil einen palpus mandibularis besitzen (Subtribus *Completa*), zum Teil eines solchen entbehren (Subtribus *Incompleta*), und welche, mit Ausnahme weniger Lanceoliden, kleine rudimentäre Augen ohne Krystallkegel besitzen.

Danach bekommen wir folgende Gruppierung:

Tribus I. **Primitiva** (mit *geteilten* Innenladen)

Subtribus I. **Completa** (*mit* Mandibulartaster):

Fam. *Pygmaeidae*	1.	Genus Mimonecteola, gen. nov.
	2.	" Microphasma, gen. nov.
	3.	" Micromimonectes (Woltereck, 1906).
	4.	" Archaeoscina (Stebbing, 1904).
Fam. *Lanceolidae*	5.	" Prolanceola (Woltereck, 1907).
	6.	" Lanceola (Bovallius, 1886).
	7.	" Scypholanceola (Woltereck, 1905).

Von diesen sieben Gattungen bilden die drei letzten die Familie *Lanceolidae* (Bovallius, 1886), während ich die ersteren (Nr. 1–4), die sich durchweg durch zwergartigen Wuchs auszeichnen, zu der neuen Familie der *Pygmaeidae* zusammenschliessen möchte, obwohl jede einzelne Gattung genug Formunterschiede aufweist, um den Wert einer neuen Familie beanspruchen zu können. Solange es sich aber um so isolierte Formen handelt, dürfte der Sammelbegriff Pygmaeidae praktischer sein.

Subtribus II. **Incompleta** (*ohne* Mandibulartaster):

Fam. *Eumimonectidae*	8.	Genus Mimonectes (Bovallius, 1886).
	9.	" Sphaeromimonectes (Woltereck, 1907).
Fam. *Chuneolidae*:	10.	" Chuneola, fam. et gen. nov.

Von diesen drei Gattungen können Nr. 8 und 9 als Familie *Eumimonectidae* zusammengefasst werden. Die Gattung *Micromimonectes* (oben Nr. 3) dagegen muss aus dieser Familie ausscheiden, da sie einen

Mandibulartaster besitzt und auch sonst eigenartig genug gebaut ist. Den Gesamthabitus allerdings hat sie mit den echten Mimonectiden, aber auch mit den neuen Formen *Mimonecteola* und *Microphasma* gemeinsam.

Diesen 10 Gattungen der *Primitiva* stehen dann die weniger ursprünglichen Sciniden und Vibiliden als

Tribus II. **Derivata**

gegenüber (mit *verschmolzenen* Kauladen und ohne Mandibulartaster).

Im folgenden sollen nur die neuen Formen der *Primitiva*, soweit sie aus den reichen Schätzen der Albatross-Expedition stammen, kurz beschrieben werden,[1] und zwar beginne ich mit den neuen Sphäromimonecten, weil sich unter ihnen eine Form befindet, die im Bau ihrer Unterlippe die betonte Zwischenstellung der ganzen Gruppe am deutlichsten illustriert.

Kap. 1.

Sphaeromimonectes Valdiviae pacifica, subsp. nov. ♂ (Fig. 6) und **Sphaeromimonectes Diomedeae**, sp. nov. ♀ (Fig. 8).

Von *Sph. Valdiviae* konnte ich bisher nur das Weibchen, und zwar aus dem Atlantik beschreiben; das nun im Pacifik gefundene *Männchen* weicht so stark ab dass man kaum eine Zusammengehörigkeit vermuten würde, wenn nicht das sehr charakteristisch geformte zweite Beinpaar des Peräons bei dem Männchen wiederkehrte (vergl. Fig. 6 und Fig. 7).

Während das erste Beinpaar keine besondere Differenzierung zeigt, ist das zweite Beinpaar (anstatt wie gewöhnlich schmäler und einfacher gestaltet zu sein als das erste) zu einer eigenartigen Greifzange umgestaltet. Der Metatarsus ist distalwärts verbreitert, aber nur bis etwa dreiviertel seiner Länge; dann wird er plötzlich ganz schmal und bildet einen kleinen Zapfen oder Stiel, auf welchen der stark gekrümmte Dactylus eingelenkt ist. Die Ventralfläche des Metatarsus ist mit mehreren Querreihen starker Borsten besetzt. Das ganze ist wahrscheinlich eine Vorrichtung, um die Kopfgliedmassen, besonders die ersten Antennen mit ihrem dichten Besatz von Spürhaaren zu *putzen.* Man kann sich vorstellen, dass die Antennen durch den zwischen Metatarsus und eingeschlagenen Dactylus ausgesparten Raum beim Putzen durchgezogen werden. Der Putzfuss der atlantischen ♀♀ unterscheidet sich von dem des pacifischen ♂ dadurch, dass beim ersteren Tarsus und Metatarsus in der üblichen Weise gegeneinander abgesetzt und gelenkig miteinander verbunden sind, während bei unserem ♂ beide Teile sich fest aneinander schliessen; dadurch ist eine erhebliche Verstärkung des ganzen Apparats erzielt.

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[1] Um eine einigermassen vollständige Aufzählung der bisher vorliegenden (meistens neuen) Formen dieses kleinen Kreises der *Primitiva* geben zu können, ist auch eine Gattung hier vorlaüfig kurz beschrieben worden, welche bisher nur von der Valdivia-Expedition erbeutet wurde (*Chuneola*), ferner musste zum besseren Verständnis der neuen Arten des Albatross-Materials auf einige von der Gauss und der Valdivia erbeutete Arten von *Scypholanceola*, *Prolanceola*, und *Sphaeromimonectes* bezuggenommen werden. Weitere neue Arten dieser Gruppe werden später in den "Ergebnissen" dieser beiden Expeditionen beschrieben werden.

Auch sonst sind die Gliedmassen des ♂ denen der ♀♀ ähnlich, aber nicht gleich.

Alle Gliedmassen sind beim ♂ erheblich stärker und relativ länger als beim ♀; einen speciellen Unterschied zeigt das 7. Beinpaar, das bei dem ♂ — aber nicht bei den atlantischen ♀♀ — stärker und länger ist als das sechste Beinpaar (vergl. Fig. 6 und Fig. 7).

Der interessanteste Unterschied betrifft die zur Unterlippe verwachsenen Kieferfüsse. Bei ♂ und ♀ sind die kleinen ventralen (zum 2. Glied gehörigen) Lamellen ebenso wenig verschmolzen wie die grossen, hinteren (das 3. Glied der Kieferfüsse repräsentierenden) Kauladen. Das ♂ zeigt aber einige wichtige Besonderheiten an diesem Extremitätenpaar. Die kleinen Lamellen sind bei ihm grösser als beim ♀ und an der ventralen Kante kräftig vorgewulstet. Dieser doppelte Wulst reicht an der Ventralfläche bis fast in die Mitte des Basalteils des 2. Gliedes herab (Fig. 4). Auch dieser Basalabschnitt lässt noch deutlich seine Zusammensetzung aus einer rechten und linken Hälfte erkennen: er ist vom Ansatz der Kauladen bis etwa zur Mitte durch eine Medianfurche geteilt.

Dieses ursprüngliche Verhalten war bisher nur für Gammariden, nicht aber für Hyperiden bekannt, wir können es indessen noch bei anderen *Hyperiidea gammaroidea primitiva* wiederfinden.

Dagegen habe ich bisher bei keiner anderen Form ein Verhalten dieses ♂ wiedergefunden, welches ganz besonders für die intermediäre Natur dieser Tiere spricht: *es findet sich nämlich an den grossen Lamellen des 3. Gliedes noch ein kleiner Taster, wie er (in höherer Ausbildung) allen Gammariden zukommt, während sein Fehlen für die Hyperiden grade den einzigen, durchweg giltigen Differentialcharakter gegenüber den Gammariden ausmacht* (Fig. 4).

Der Taster ist bis auf ein Glied reduziert (das grosse Aehnlichkeit mit der bei manchen Hyperiden zu einem Stiftchen gewordenen 2. Antenne hat) aber dieser Rest des ursprünglich 5-gliedrigen Tasters ist durch eine deutliche Ringlinie von der Lamelle abgesetzt; und er sitzt dieser an einer Stelle seitlich auf, die nur wenig mehr distal gelegen ist als der Ansatzpunkt des Tasters mancher Gammariden (Fig. 2–3). Das Ende des rudimentären Tasters trägt eine starke, in der üblichen Weise eingesenkte Borste.

Bei den atlantischen Formen sind diese ursprünglichen Charaktere weniger deutlich ausgeprägt, das Basalglied des 2. Gliedes ist nur undeutlich eingekerbt und aus dem Taster ist ein konischer, borstentragender Fortsatz geworden, dessen Basis ganz allmählich in die Lamelle übergeht.

Bei anderen Sphäromimonectiden fehlt auch dieser Fortsatz, und dadurch kommt dann das für die Hyperiden bisher allein bekannte Bild einer ganzrandigen Lamelle zu Stande, die jeder Andeutung eines Gammariden-Tasters entbehrt.

Wenn schon die aufgezählten Gliedmassen-Unterschiede unseres pacifischen ♂ von den atlantischen ♀ ♀ über den Rahmen der Geschlechtsunterschiede hinausgehen, so würde der abweichende Habitus des Albatross-Exemplars nach Bovallius' Definitionen genügen, um dieses Tier einer ganz anderen Familie zuzuweisen, als grade den Mimonectidea, die in erster Linie durch den ballon-artig aufgeblähten Körper charakterisiert werden. Denn das vorliegende Exemplar hat einen ganz typischen Gammariden- oder Sciniden-Körper. Dennoch gehen die Uebereinstimmungen des Baus der einzelnen Körperteile soweit, dass zum mindesten eine sehr nahe Verwandschaft sicherlich anzunehmen ist. Ich schlage deshalb vor, vorläufig eine subspecies *pacifica* der atlantischen Art anzunehmen. Erst wenn das pacifische zugehörige ♂ und ebenso das atlantische ♀ gefunden sein wird, wird sich entscheiden lassen, ob die aufgeführten Unterschiede des 2. und 7. Beinpaars, der Maxillipeden und des Gesamthabitus *mehr* als Subspecies-Unterschiede sind. (In diesen Falle wäre die neue Art als *Sph. pacificus* aufzuführen.)

Das vorliegende Exemplar, ein ziemlich reifes ♂, wurde von der Albatross-Expedition auf Station 4709 erbeutet.

Sphaeromimonectes Diomedeae, sp. nov. (Fig. 8).

Diese Art hat mir der vorigen den *Scina*-ähnlichen Habitus überein, der auch für eine dritte, von mir früher beschriebene Species *Sph. scinoides* charakteristisch ist. Doch ist die neue Art auf den ersten Blick als etwas Besonderes zu erkennen: während nämlich jene beiden Arten wie alle übrigen Mimonectiden zart und durchsichtig sind, ist *Sph. Diomedeae* ein ausserordentlich derbes und dabei intensiv rot gefärbtes Tier, etwa von der Färbung und Stärke des Chitins wie eine *Lanceola Sayana.* Auch die Buckel- und Leisten-förmigen Vorsprünge an den Seitenwänden der Peräonsegmente erinnern an derbe Lanceoliden.

Dennoch handelt es sich um eine *Sphaeromimonectes*-Art, welche dem 1904 von mir kurz beschriebenen *Sph. Gaussi* im Bau ihrer Körperanhänge am nächsten steht. Doch ist sie von jener — abgesehen von der Form und Beschaffenheit des Körpers — durch den Bau der beiden Antennenpaare leicht zu unterscheiden: die erste Antenne ist bei *Sph. Gaussi* kürzer als die Kopfhöhe beträgt, bei *Sph. Diomedeae* erheblich länger; die 2. Antenne ist bei jener Art auf ein einfaches Stiftchen reduziert, bei der neuen Art dagegen dreigliedrig.

Im Körperhabitus gleicht *Sph. Diomedeae* am meisten dem 1906 von mir aus dem Indik beschriebenen *Sph. scinoides*, jedoch hat diese Art einen zarten und hyalinen Körper, auch hat sie längere und viel schmälere Antennen, ebenso sind die 3 letzten Beinpaare viel dünner als bei unserer pacifischen Art, und die Metatarsen der Gnathopoden (1. und 2. Peräon-Beinpaar) entbehren der den Dactylus überragenden Fortsätze.

Am grössten ist die Uebereinstimmung zwischen *Sph. Diomedeae* und einer von Stebbing[1] 1904 aus dem Atlantik beschriebenen neuen Gattung und Art: *Paras-*

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[1] Trans. Linnean Soc., X, 2.

cina Fowleri. Ich würde es sogar für nicht ausgeschlossen halten, dass die zwischen Stebbings und meiner Art bestehenden Unterschiede auf Altersdifferenz beruhten, da das *Parascina*-Exemplar nur 8.75 mm. das grösste meiner Exemplare (ohne Antennen) ca. 14 mm. misst. Doch besitze ich aus dem Atlantik ein etwa gleich grosses Exemplar, das unverkennbar ein beinah ausgewachsenes *Parascina Fowleri* (Stebbing) ♀ ist. Zwischen ihm und dem pacifischen *Sph. Diomedeae* ♀ konstatiere ich folgende Unterschiede: der den Dactylus überragende Vorsprung des Metatarsus ist bei *P. Fowleri* schmal und unbehaart, während er bei *Sph. Diomedeae* breit ist und mehrere Borsten trägt. Der Innenast der 1. Uropoden ist bei *P. F.* etwas länger als das Stammglied, bei *Sph. D.* kürzer. Der Femur des 7. Brustbeinpaares ist bei *P. F.* ebenso lang wie der des 5. Beinpaares, bei *Sph. D.* länger. Der grösste Unterschied findet sich noch in den Mundteilen, besonders in den Maxillipeden. Die inneren Laden sind bei *Sph. D.* bis zum proximalen Ende des 2. Gliedes der Kieferfüsse (das mit dem 1. verwachsen zu sein scheint) gespalten, und sehr breit; ihr distales Ende trägt eine stärkere Borste neben einer Anzahl schwächerer Haare. Bei *P. F.* lässt sich der Spalt nicht so weit proximalwärts verfolgen, die Laden sind schmäler und entbehren der Endborste. Auch die grossen Innenladen sind verschieden: bei *Sph. D.* ♀ ist ihr oberer Rand dort, wo beim *Sph. Valdiviae* ♂ der rudimentär Taster sitzt, tief eingekerbt, in der Kerbe inserieren zwei Borsten dicht aneinander. Bei *P. F.* fehlt die Einkerbung, der Rand trägt drei einzelstehende Borsten.

Das sind natürlich keine Unterschiede, welche 2 Gattungen von einander trennen können. Vielmehr sind *Parascina Fowleri* und *Sph. Diomedeae* zwei sich recht nachstehende Arten, denen sich noch eine dritte, von der Valdivia im Atlantik gefundene Art, sowie der *Sph. scinoides* der Gauss-Expedition (ebenfalls aus dem Atlantik) anschliesst.

Diese 4 Arten von *Scina*-ähnlichem Habitus würde ich unbedenklich in der Stebbing'schen Gattung *Parascina* vereinigen, wenn nicht auch *Sph. Gaussi* und weiterhin *Sph. cultripes* und *Valdiviae* ihr Recht verlangten. Auch diese werden, *soweit der Bau der Gliedmassen in Betracht kommt*, nur durch *Art*-unterschiede von jenen vier Species getrennt; dagegen wird der Habitus der Tiere durch die monströse Aufblähung des Peräons (Dorsal- *und* Ventralfläche) ein grundverschiedener, vielleicht allerdings — im Gegensatz zu *Mimonectes* — nur bei den ♀♀, da das einzige bekannte ♂ (von *Sph. Valdiviae*) wiederum sehr an *Scina* erinnert. Es scheint mir nicht passend zu sein, auch Formen wie Fig. 7 als "*Parascina*" zu bezeichnen. Nicht viel weniger unpassend ist allerdings der von mir einstweilen beibehaltene Name *Sphaeromimonectes* für die letztbeschriebenen Arten, z. B. für *Sph. Diomedeae* (Fig. 8).

Das Prioritätsgesetz giebt uns keine Entscheidung über den Gattungsnamen, da im gleichen Jahre 1904 die beiden Extreme dieser Formengruppe von Stebbing und mir unter den entsprechenden, nach so verschiedenen Seiten weisenden Namen beschrieben wurden: ein merkwürdiger und für die Zwischenstellung dieser Tiere recht charakteristischer Beitrag zur Amphipoden-Nomenklatur.

Die neue Art wurde auf Stat. 4667 erbeutet.

KAP. 2.

Chuneola paradoxa, gen. et sp. nov. (Fig. 9).

Eine kurze Beschreibung dieser neuen Form sei der Vollständigkeit wegen hier eingefügt, obwohl sie bisher nur von der Valdivia-Expedition im Indik (Stat. 225) erbeutet worden ist.

Wegen der paarigen (mit je einer kräftigen Endborste versehenen) Innenladen der Maxillipeden gehört sie zu den *Hyperiidea gammaroidea primitiva*, mit denen sie aber auch andere Charaktere teilt: den nicht abgesetzten Kopf, das rudimentäre Auge und 2. Antennenpaar, ferner die Gestalt der 1. Antennen (angeschwollenes erstes Geisselglied und rudimentäres Geisselende).

Ihre Einordnung in eine der bestehenden Familien ist unmöglich, da sie sowol von Lanceoliden als von Sciniden und Sphäromimonectiden, endlich auch von *Micromimonectes* einzelne Züge entlehnt.

Am auffälligsten ist die Aehnlichkeit mit den Lanceoliden, deren hauptsächliches Charakteristikum bekanntlich die in eine runde Höhlung des Metatarsus rückziehbaren Endklauen des 5.–7. Beinpaars sind. Diese besitzt *Chuneola* auch, *aber bei ihr endigen auch das 3. und 4. Beinpaar in der gleichen Weise*, nur dass hier, wie üblich, die Metatarsen nach hinten gerichtet sind, während sie an den drei letzten Beinpaaren nach vorn eingeschlagen werden.

Weitere Unterschiede von Lanceoliden sind folgende: die Mandibulartaster fehlen und die 2. Antennen sind rudimentär (beides wie bei *Scina* und *Sphäromimonectes*). Ferner sind die paarigen Innenladen der Kieferfüsse nicht lappenförmig (wie bei *Lanceola* und *Sphäromimonectes*) sondern röhrenförmig (wie bei *Micromimonectes*).

Besondere Eigentümlichkeiten dieser Form sind folgende: der Körper ist abgeplattet, wie der einer *Dairella*, sodass er fast doppelt so breit als hoch erscheint; der Kopf erhält durch eine breite Stirnwölbung und das hoch heraufgerückte, weit vorspringende Epistom ein ganz absonderliches Gepräge, das durch die kurzen, leicht nach oben gebogenen Antennen noch verstärkt wird. Der Mundapparat ist sehr stark entwickelt.

Auffällig ist ferner insbesondere das 3. und 4. Beinpaar, einesteils durch seine Länge und die Breite seiner Glieder, andrerseits durch die erwähnten einziehbaren Lanceoliden-Krallen. Von den 3 letzten Beinpaaren ist das 5. das schwächste, das 7. das stärkste. Bemerkenswert ist weiter, dass die innere Platte der 1. Maxillen rudimentär ist und dass der Urus sich durch seine Länge und Schmalheit, sowie durch die Kürze seiner Gliedmassen auszeichnet (Fig. 9). Auch die Pleopoden sind schwach entwickelt; wir müssen annehmen, das wir es in diesem seltenen und seltsamen Geschöpf mit dem Parasiten einer Tiefsee-Tunikate oder Meduse (Siphonophore?) zu tun haben. Es wird sich vorzugsweise mit dem 3. und 4. Beinpaar an oder in seinem Wirt festklammern, während von anderen Raumparasiten unter den Hyperiden das 5. oder 6. Beinpaar zu gleichem Zweck ausgebildet zu sein pflegt.

Damit haben wir die kleine Gruppe der *Incompleta* erschöpft und wenden uns nun in den weiteren Kapiteln der grösseren Gruppe der *Completa* zu, und zwar zunächst der neuen Familie *Pygmaeidae* (vergl. die Übersicht auf Seite 147).

Kap. 3.

Mimonecteola Diomedeae, gen. et sp. nov. (Fig. 10).

Auch diese neue Form passt in keine der bestehenden Familien hinein, sondern vereinigt in ihrer Organisation Lanceoliden- und Mimonectiden-Eigenschaften mit neuartigen Zügen.

Während bei *Chuneola* die Beine — im Gegensatz zu den Kopfgliedmassen — lanceolidenähnlich waren, sind es hier umgekehrt die Teile des Kopfes (Antennen, Maxillipeden, Mandibulartaster, Kopfform) welche einer *Lanceola* entnommen zu sein scheinen (Fig. 10), während die Peraeopoden des 3. bis 7. Paares ganz abweichend gestaltet sind. Sie erinnern noch am ersten an die entsprechenden Gliedmassen eines *Sphäromimonectes;* jedoch sind die dünnen und jeder Endanschwellung entbehrenden Metatarsen durch ihre gebogene Gestalt und ihre Länge, die Tarsen dadurch ausgezeichnet, dass sie von einem auffallend kräftigen, bis zum Tibia-ansatz reichenden Muskel aufgetrieben sind, der im Stande sein muss, die Metatarsen sehr kräftig einzuschlagen — wahrscheinlich auch dies eine Anpassung an Raumparasitismus.

Ungewöhnlich sind auch die sehr zarten und dünnen Dactyli der *Mimonecteola*, welche den stärksten Gegensatz zu den kurzen, kreisförmig gebogenen und borstentragenden Dactyli der Lanceoliden bilden und ausserdem, da sie nicht rückziehbar sind, einen ganz abweichenden Muskelmechanismus im Metatarsus aufweisen.

Mimonecteola Diomedeae wurde von der Albatross-Expedition auf Stat. 4717 und 4655 gefangen.

Kap. 4.

Microphasma Agassizi, gen. et sp. nov. (Fig. 11).

Wieder ein ganz anderes Bild bieten die Peraeopoden, und zwar des 3. bis 6. Paares, bei dieser ebenfalls neuen und absonderlichen Hyperide des Albatross-Materials.

Hier ist es nicht der Tarsus, sondern der Metatarsus, welcher durch starke Muskeln auffällt und vergrössert ist. Und dementsprechend wird nicht, wie bei der vorigen Art, der Metatarsus, sondern der kräftig entwickelte Dactylus gegen das vorhergehende Glied eingeschlagen und dient zum Festhalten.

Merkwürdig ist, dass den gleichgestalteten Beinen des 2. und 3. Paares (diese sind ja in der Regel gleichartig) hier das 4. Beinpaar spiegelbildlich vollständig gleich ist, während die beiden letzten Paare an der Umgestaltung nicht teilhaben. Auch dieses Verhalten wird man wieder als die Anpassung eines

Raumparasiten an irgend welche besondere Raumverhältnisse seines Wirtes zu deuten haben.

Im übrigen finden wir auch bei *Microphasma* Mimonectiden-Charaktere mit solchen von *Lanceola* vereinigt.

Körperform und Kleinheit stimmen mit *Micromimonectes* überein, Mandibulartaster und Maxillipeden (deren Innenplatte nur bis zur Hälfte geteilt, also zweizipflich ist) ähneln denjenigen von *Lanceola;* die aus 3 rudimentären Gliedern bestehenden 2. Antennen gleichen denjenigen von *Mimonectes,* die ersten Antennen endlich zeigen ein kurzes kegelartig zugespitztes Geisselglied wie eine *Vibilia.* Charakteristisch für die höchst wahrscheinlich parasitische. Lebensweise ist die schwache Ausbildung der Schwimmfüsse (Pleopoden) und der ungemein kräftige Bau der Kauwerkzeuge, welche den unteren Teil des Kopfes in einer sehr merkwürdigen Weise über den oberen Teil das Uebergewicht erlangen lassen (Stat. 4663).

KAP. 5.

Micromimonectes (WOLTERECK, 1906) (Fig. 12) und **Archaeoscina** (STEBBING, 1904). [A. STEBBINGI, sp. nov. (Fig. 13).]

Von diesen beiden Formen hat das Albatross-Material zwar nichts Neues erbracht, aber doch gezeigt, dass beide Gattungen auch im Pacifik vorkommen; ein junges Exemplar von *Micromimonectes* fand sich in Stat. 4655, ein solches von *Archaeoscina* in Stat. 4704.

Die letztere Gattung war bisher nur in einem einzigen sehr winzigen Exemplar bekannt, das von Stebbing[1] aus dem Atlantik beschrieben wurde.

Wegen der überraschenden Uebereinstimmung der Gliedmassen mit den von mir aus dem Indik beschriebenen (geschlechtsreifen) *Micromimonectes*-Arten habe ich 1906 die Möglichkeit betont, dass *Archaeoscina* eine Jugendform jener Gattung darstellen könne.

Durch den Fund der Albatross-Expedition bin ich nun in den Stand gesetzt, diese Auffassung zu revidieren: da mein Exemplar auch bei ca. 3 mm. Länge die von Stebbing für sein ca. 1½ mm. langes Exemplar angegebenen Merkmale unvermindert zeigt, während der nur etwa 4 mm. lange *Micromimonectes* des Albatross-Materials bereits die Charaktere seiner Gattung unverkennbar zur Schau trägt, gebe ich jene Vermutung auf. *Archaeoscina* und *Micromimonectes* stehen sich zwar nahe, aber nur als zwei getrennte, im Habitus durchaus verschiedene Gattungen einer Familie, der *Pygmaeidae.*

Die besonderen Uebereinstimmungen dieser beiden Gattungen im Gegensatz zu den übrigen benachbarten Gattungen *Microphasma* und *Mimonecteola* sowie zu den Lanceoliden betreffen vor allen den Kopf: beide Antennenpaare endigen mit je zwei langen Fäden, und die Mandibulartaster haben ein schmales, medianwärts eingeschlagenes Endglied, dessen Länge die der beiden übrigen Glieder des Palpus übertrifft (bei *Lanceola* kurz und nicht eingeschlagen).

Die Unterschiede zwischen beiden Gattungen sind andererseits sehr gross:

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[1] Loc. cit.

während *Archaeoscina* eine ganz typische Gammaridenform hat und in der Länge und Haltung des 5. Beinpaares merklich an *Scina* erinnert, bringt die Gattung *Micromimonectes* in der Art *M. typus Physosoma* mit ihren zu einer einheitlichen Blase verschmolzenen Peräonsegmenten eine Hyperidenform hervor, die auch von den "Physosoma"-Larven der Thaumatopsiden, von denen diese Art ihren Namen erhalten hat, nicht übertroffen werden.

Durchweg sind die Massverhältnisse Kopf zu Körper für beide Gattungen grundverschieden: der Kopf von *Micromimonectes* ist — von vorn oder oben gesehen — um ein vielfaches schmaler als die darauf folgenden Segmente, der *Archaeoscina*-Kopf dagegen ist auffällig breit, ebenso breit als der Körper. Er trägt ferner überaus mächtige und lange 1. Antennen (die mit Endfäden so lang wie Peräon-Segment 1–5 sind!), während die entsprechenden Antennen der anderen Gattung nicht einmal das erste Körpersegment an Länge erreichen.

Der vielleicht wichtigste Unterschied liegt endlich im Bau des Maxillipeden, deren innere Laden bei *Micromimonectes* geteilt und röhrenförmig gestaltet sind, während bei *Archaeoscina* nur das distale Ende der inneren Laden in zwei Zipfel geteilt erscheint (bei dem Albatross-Exemplar).

In diesem Punkte schliesst sich *Archaeoscina* weit enger an *Lanceola* an, als *Micromimonectes* mit seinen ganz eigenartig gestalteten Kieferfüssen.

Was nun endlich das Verhältniss des neuen pacifischen Exemplars jener wichtigen Gattung zu der durch Stebbing entdeckten atlantischen Art anbelangt, so erweisen sich die Unterschiede vor allem der Kopfgliedmassen als zu grosse, um durch die Altersdifferenzen oder etwa als lokale Subspecies-Merkmale ihre Erklärung zu finden.

Die 1. Antennen entspringen bei der atlantischen Art *Arch. Bonnieri* mit breiter, bei der neuen Art, welche ich zu Ehren des Entdeckers der Gattung *Arch. Stebbingi* nennen möchte, mit sehr schmaler Basis. Das Hauptglied der 1. Antennen ist bei *Arch. Bonnieri* etwas $\frac{2}{3}$ so lang als die 3 Endglieder zusammen; bei *Arch. Stebbingi* dagegen *ca. 5 mal solang* (in beiden Fällen die Endfäden nicht mitgerechnet).

Die 2. Antennen von *Arch. Bonnieri* bestehen aus "4 peduncular joints, none of them very long, followed by 1 or 2 small flagellar joints and at the end the needle-like spine, longer than all the joints of the appendage together." Ganz anders ist die 2. Antenne von *Archaeoscina Stebbingi* gebaut: auf ein kurzes Basalglied folgt ein über doppelt so langes Glied und auf dieses drei kurze Endglieder, welche zusammen so lang sind wie jenes Hauptglied. Das Endglied trägt eine lange und eine kürzere einfache Borste. Am seitlichen distalen Rande des 2. und 3. Gliedes dagegen entspringt je eine mit feinen und langen Fiederchen zweizeilig besetzte Sinnesborste. Endlich sind in den Längen- und Breitenverhältnissen der Beine erhebliche Unterschiede zu bemerken, so ist bei *A. Bonnieri* das 3. Beinpaar kürzer als das 5., während es bei *A. Stebbingi* umgekehrt wesentlich länger ist. Die grössere Breite der Metatarsen des 1. und 2. Beinpaares bei *A. Stebbingi* kann vielleicht auf dem Altersunterschied beruhen, ebenso die übrigen derartigen Differenzen. Die aufgezählten Besonderheiten der neuen Art genügen aber reichlich zu ihrer sicheren Unterscheidung.

Auch der Mandibeltaster ist bei *A. Stebbingi* eigenartig gebaut: das stark gebogene, mit vielen nach innen gekrümmten Borsten versehene Endglied ist nicht weniger als dreimal länger als die beiden Basalglieder zusammen; bei *A. Bonnieri* ist es nur um $\frac{1}{3}$ länger als jene.

KAP. 6.

Fam. Pygmaeidae und Fam. Lanceolidae.

Die Familie *Pygmaeidae*, welche ich der wolabgegrenzten Familie *Lanceolidae* gegenüberstelle, und welche ausser den beiden zuletzt diskutierten Gattungen noch die Genera *Microphasma* und *Mimonecteola* umfasst, lässt sich wie folgt charakterisieren: kleine und sehr hyalindünnhäutige Hyperiden von meist stark aufgeblähter Körperform; Kopf ohne Rostrum mit rudimentären punktförmigen Augen ohne Krystallkegel; 1. Antenne mit verdicktem Geisselglied; 2. Antenne 3- oder mehrgliedrig; Mandibel mit 3-gliedrigen Palpus; Kieferfüsse mit 2-teiliger Innenlade; Beinpaar 1 und 2 lanceola-ähnlich, besonders das erste mit verbreitertem Metatarsus und Tarsus; die übrigen Beinpaare verschieden gestaltet, aber stets *ohne rückziehbare Endklauen;* Aussenast der Uropoden nicht mit dem Basalglied verschmolzen; Telson kurz.

Die Familie *Lanceolidae* wird von Bovallius,[1] 1887, wie folgt definiert: "The head is small, short, not tumid. The eyes are small or indistinct. The first pair of antennae are straight, fixed at the anterior side of the head, the flagellum is compressed, the first joint very large, the following small, terminal, few in number. The second pair are compressed, not angulated, fixed at the anterior side of the head. The mouth-organs are adapted for mastication, the mandibles are provided with palpi. The pereiopoda are walking legs, the seventh pair not transformed. The uropoda are provided with rami."

Diese Definition konnte noch 1904 gelten, als von Stebbing 9 Arten, sämtlich der Gattung *Lanceola* angehörig, aufgezählt wurden.

Durch die von mir beschriebenen Gattungen *Scypholanceola* und *Prolanceola* hat aber diese Familie ein stark verändertes Aussehen bekommen und die Diagnose bedarf einer neuen Fassung, die etwa folgendermassen lauten müsste:

Mittelgrosse bis grosse Tiere von mässighyaliner bis derber Körperbeschaffenheit und mässig aufgetriebener Form (niemals so zarthäutig und so aufgebläht wie in der vorigen Familie); Körper durchsichtig oder rotgelb bezw. gelbbraun gefärbt; Kopf meistens kürzer als 1. Peraeonsegment; Auge meistens klein und meistens ohne Krystallkegel (oder mehrteilig oder stark vergrössert); erste Antennen mit einem verdickten Geisselglied, und mehreren kleinen Endgliedern, zweite Antennen schmal, mehrgliedrig; *Mandibel mit 3-gliedrigem Taster; Kieferfüsse mit gespaltener Innenlade.* Erstes Beinpaar mit handartig verbreitertem Tarsus und Metatarsus; *5.–7. Beinpaar mit einer distalen Vertiefung im Metatarsus und rückziehbarem Dactylus*, Uropoden mit nicht verwachsenem Aussenglied, Telson lang oder kurz.

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[1] Bihang Svenska Akad. Handl., XI, 16.

Kap. 7.

Prolanceola vibiliformis (Woltereck, 1907) ♀ (Fig. 14).

Von dieser eigenartigen Gattung konnte ich bisher nur das ♂, das die Valdivia im Indik erbeutete, beschreiben (Fig. 15); jetzt bin ich in den Stand gesetzt, auch das vom Albatross auf Station 4667 gefangene ♀ bekannt zu geben. Die gefundenen Unterschiede scheinen nicht mit Sicherheit den Rahmen der möglichen Sexualdifferenzen zu überschreiten, obgleich sie nicht unerheblich sind: der Körper des ♀ ist schwach gekielt, der des ♂ gar nicht. Der Kopf des ♂ ist vorn (Stirn) konvex vorgewölbt, der des ♀ ist konkav eingesenkt. Die Basalglieder der 1. Antenne sind beim ♂ mächtig entwickelt, beim ♀ rudimentär. Das 6. und 7. Segment erscheint beim ♀ gegenüber den übrigen Segmenten stark verkürzt beim ♂ nicht.

Diesen Unterschieden steht eine so weitgehende Uebereinstimmung im Bau der Gliedmassen, vor allem der sonderbaren Klappschere des 1. Beinpaares und des *Scina*-artig verlängerten und getragenen 5. Beinpaares gegenüber, dass ich geneigt bin, die aufgezählten Unterschiede der Geschlechtsdifferenz zuzuschreiben. Höchstens kann sich noch herausstellen, dass wir auch bei dieser Art eine lokale Subspecies ("*pacifica*") von der Indik-Form, der das ♂ angehört, unterscheiden müssen.

Einen interessanten Befund konnte ich noch an *Prolanceola* machen, der den Bau des *Auges* betrifft.

Die Augen aller bisher bekannten Lanceoliden, Sciniden und der sämtlichen *Hyperiidea gammaroidea primitiva* (also *alle Hyp. gamm.* mit Ausschluss einiger Vibiliden) sind klein und liegen in einem seitlichen, über dem Ansatz der 2. Antennen befindlichen Vorsprung der Kopfwandung.

Ein solcher Vorsprung mit dem zugehörigen Augenfleck und Opticusnerv findet sich auch bei *Prolanceola.* Aber ausserdem findet sich eine Reihe von 4 weiteren Augenflecken am Kopf, die in einem (nach vorn offenen) Bogen von jenem Augenvorsprung nach der oberen Kopfgrenze hinzieht. (Siehe Fig. 14.) Diese Augenflecken zeigen keinerlei Vorwölbungen der Kopfwandung. Jeder von ihnen stellt einen flach ausgebreiteten Zellhaufen dar, ohne jede Spur von einem optischen Apparat, doch wird jeder einzelne von einem deutlichen Ast des Opticus innerviert.

Wir werden auf diesen überraschenden Befund bei der Besprechung des grossen Auges von *Scypholanceola* zurückzukommen haben.

Kap. 8.

Die Gattung Lanceola (Bovallius, 1884).

Unter all den vielgestaltigen *Hyperiidea gammaroidea primitiva* stellen die Lanceoliden s. str. das Gros dar, um welches sich jene übrigen einesteils altertümlichen und primitiven, anderenteils merkwürdig differenzierten und wohl stets sehr seltenen Erscheinungen gruppieren, die wir kennen gelernt haben und in *Scypholanceola* noch besprechen werden. Indessen war auch die eigentliche Gattung *Lanceola* bis 1904 nur in einer *kleinen* Kopfzahl bekannt, da es sich vorwiegend um Bewohner des Tiefsee-Planktons handelt. 9 Arten wurden 1904 von Stebbing anerkannt; zu diesen haben die Expeditionen des letzten Jahrzehnts noch eine kleine Anzahl neuer gefunden. Vor allem aber haben die reichen Materialien dieser Expeditionen die Möglichkeit gegeben, in den Bau der Tiere etwas tiefer einzudringen. Eins der Ergebnisse dieser Prüfung ist dieses, dass die eigentlichen *Lanceola*-Arten in 2 scharf gesonderte Hauptgruppen geschieden werden müssen, nämlich in solche *mit Krystallkegeln im Auge und solche, deren Krystallkegel geschwunden sind.*

Für beide Gruppen, die man auch als Unter-Gattungen unterscheiden könnte, enthält das Albatross-Material Neues, das hier indem nur kurz charakterisiert werden soll. Ich verweise auf die spätere ausführliche Darstellung.

(a) *Lanceola*-Arten *mit* Krystallkegeln.

Hier ist vor allem die grosse *Lanceola Sayana* zu nennen, die von Bovallius, 1885, im Atlantik gefunden wurde (Fig. 17). Sie fehlt, wie das Albatross-Material zeigt, auch im Pacifik nicht und zwar kommt sie hier in zwei Formen vor: in einer grossen, welche der von Bovallius beschriebenen mindestens sehr nah steht, und in einer kleineren, welche sich von jener recht erheblich, aber hauptsächlich durch die Massverhältnisse ihres Körpers unterscheidet. Ich begnüge mich deshalb damit, die neue Form als "subsp. *longipes*" zu der Art *L. Sayana* zu stellen (Fig. 16).

Lanceola Sayana var. *longipes.*

Zeichnet sich 1. durch einer ausserordentlich schlanken — sowohl dorsi-ventral als lateral komprimierten — Körper aus, im Gegensatz zu dem fast eiförmigen Rumpf, welcher der typischen Form (auch in ihren Jugendstadien) eigentümlich ist.

2. Ist die relative Länge der Peraeon-Gliedmassen eine erheblich grössere als bei der typischen Form (vergl. Abbildung 16 und Abbild. 17). So übertrifft z. B. die Länge des 6. Fusspaares bei einem pacifischen *longipes*-♂ die Länge des ganzen Peräons um ein Fünftel, während bei einem gleichgrossen pacifischen ♂ des *L. Sayana typica* das Peräon nur um $\frac{1}{10}$ seiner Länge vom 6. Fusspaar übertroffen wird.

3. Ist der Kopf der var. *longipes* höher und schmaler als der von *typica*, wobei ich wiederum zwei gleichgrosse Exemplare vergleiche (vergl. Abbildung 18 a und b).

4. Die seitlichen Vorwölbungen des Kopfes, welche die Augen enthalten, sind bei var. *longipes* schräg nach unten gerichtet, wahrend ihre Achse bei *typica* rechtwinklig zur medianen Körperebene steht (vergl. Abb. 18 a und b).

5. Die Gesamtgrösse der geschlechtsreifen Tiere ist bei var. *longipes* eine wesentlich geringere als bei *typica*. Mir liegen zwar keine vollständig ge-

schlechtsreifen Tiere der neuen Varietät vor, wol aber bin ich in der Lage, gleichgrosse und auch gleichaltrige Tiere beider Formen auf die Ausbildung ihrer Geschlechtsorgane, ihres Gehirns und ihrer Körperanhänge zu untersuchen. Es liess sich feststellen, dass z. B. zwei gleichgrosse ♂♂ sich in folgenden Punkten unterscheiden: das typica-♂ (Stat. 4604) zeigt ein noch wenig differenziertes, grosses Gehirn, was bei diesen Hyperiden stets auf Unreife der ganzen Organisation schliessen lässt. Damit stimmt überein, dass die Hodenanlage bei diesem Exemplar nur erst eben nachweisbar ist. Das gleichgrosse *longipes*-♂ (Stat. 4665) weist dagegen ein fertig ausgebildetes, kleineres Gehirn auf, und besitzt schon weit entwickelte Hoden.

Dennoch scheint das unreifere ♂ (*typica*) älter zu sein als das reifere *longipes*-♂, da es an den Pleopod-Aussengliedern ein Segment mehr entwickelt zeigt als jenes. Wir haben also anzunehmen, dass die typische Form von *L. Sayana* bedeutend längere Zeit zu ihrer vollen Ausbildung braucht als die kleinere und früher reifende var. *longipes*.

Man wird kaum fehlgehen, wenn man auch an eine *biologische* Verschiedenheit der beiden Formen, etwa in dem Sinne denkt, dass *L. Sayana typica* in bezw. an grösseren Medusen lebt, während var. *longipes* sich an kleinere Wirtstiere oder auch wieder an die selbständige pelagische Lebensweise angepasst hat.

Es erscheint der Erklärung bedürftig, dass diese neue Form des Albatross-Materials nicht als neue Art aufgefasst wird. Doch lässt sich bei aller Verschiedenheit der relativen Abmessungen kein einziges Teil des Körpers nachweisen,. das bei der neuen Form völlig abweichende Gestalt hätte. Vor allem sind die ersten Antennen, deren Endgliedes bei jeder *Lanceola*-Species etwas anders gestaltet sind, bei dieser Varietät ganz wie bei der Stammart geformt (Abb. 19).

Lanceola felina (Bovallius) *longipes*, var. nov.

Die ersten Antennen sind es, welche uns auch gestatten, der im Folgenden kurz zu charakterisierenden Lanceolide des Albatross-Materials ihren richtigen Platz anzuweisen. *L. felina* ist die zweite bisher bekannte *Lanceola*-Art, welche Krystallkegel im Auge besitzt; sie unterscheidet sich von *L. Sayana* nach Bovallius vor allem dadurch, dass die Beine relativ kürzer sind und auch das 6. Beinpaar das Peräon nicht an Länge übertrifft. Die pacifischen Exemplare dieser bisher nur aus dem Atlantik bekannten Art besitzen nun längere Beine (und würden deshalb, da auch das Telson länger ist als bei der typischen *L. felina*, zu *L. Sayana* bezw. ihrer var. *longipes* zu stellen sein). Aber die ersten Antennen endigen ganz in der für *L. felina* charakteristischen Weise (Abb. 20) und wir haben deshalb die pacifische Form zu dieser Art zu stellen und zwar am zweckmässigsten ebenfalls als var. *longipes*. Auch hier mögen ähnliche biologische Differenzen mit der Stammart vorliegen, wie ich sie oben für *L. Sayana* vermutungsweise aussprach: Anpassung an einen andern Wirt oder Rückanpassung an das pelagische Leben.

Für eine ganze Anzahl anderer Hyperiden scheint mir aus dem Material der Albatross- und der anderen Expeditionen hervorzugehen, dass sie in ähnlicher

Weise in kleinere und grössere, langbeinige und kurzbeinige biologische Rassen oder Varietäten gespalten sind. Aus diesem Grunde wurde hier auf diese beiden *longipes*-Variationen des Albatross-Materials etwas näher eingegangen.

Ein reifes ♂ von *L. felina* var. *longipes* wurde von der Albatross-Expedition auf Stat. 4733 erbeutet.

(b) *Lanceola*-Arten *ohne* Krystallkegel.

Diese Gruppe umfasst eine viel grössere Zahl von Arten als die vorige. Allen ist die grössere Reduktion der Augen gemeinsam, deren Ommatidien jedes Restes von Krystallkegeln entbehren, während die Rhabdome oft kräftig entwickelt, ja gewuchert sind. Solche Formen leiten dann, wie wir sehen werden, zu der Gattung *Scypholanceola* über.

Folgende bisher bekannte Arten gehören zu dieser Gruppe b: 1. *L. pacifica*, 2. *L. aestiva*, 3. *L. serrata*, 4. *L. Clausi*. Von diesen fanden sich nur die beiden ersten im Albatross-Material.

Lanceola pacifica (STEBBING) *robusta*, var. nov.

Von *L. pacifica* fand sich neben einigen Exemplaren, welche der Beschreibung Stebbing's entsprechen, eine neue Varietät, welche vor allem durch ihre ausserordentlich feste, panzerartige Körperwand und die kräftigen Käferfüssen eher als den Gliedmassen planktonischer Hyperiden gleichenden Beine ausgezeichnet ist. Diese Eigentümlichkeiten fallen um so mehr auf, als die Körperwand von *L. pacifica* ausdrücklich (und mit Recht für die Hauptart) als "pellucid, in delicacy almost *like tissue-paper*" von Stebbing im Gegensatz zu der etwas festeren *L. Sayana* gestellt wird.

Auch hier aber müssen wir die neue Form, obwohl ihr Habitus so stark als möglich von dem der forma typica abweicht, als Varietät dieser unterordnen, denn die Gliedmassen und insbesondere die ersten Antennen stimmen in ihren Einzelzügen überein. — Die neue Varietät oder Subspecies wurde u. a. auf Station 4683 vom Albatross gefunden.

Auch hier müssen wir an eine *biologische* Varietät denken, und zwar scheint der Fall so zu liegen, dass die var. *robusta*, die wie die meisten Lanceoliden nur in Tiefenfängen vorkommt, an grossen *Tiefsee-Siphonophoren* schmarotzt, deren kräftig muskulöse Senkfäden und Fresspolypen zartwandigeren Gästen gefährlich werden würden, aber diesen gepanzerten Gesellen nichts anhaben können. Im Darm meiner sämtlichen Exemplare dieser interessanten Lanceolide fanden sich grosse Mengen von auffallend langen, oft ein wenig gekrümmten Nesselkapseln, wie sie mir in ähnlicher Form nur von Siphonophoren bekannt sind. Die var. *robusta* zeichnet sich durch tiefrote Farbe aus, während die Hauptart eher blasshyalin zu sein scheint.

Geringeres Interesse bietet die pacifische Form von *L. aestiva* dar, die sich von den atlantischen Exemplaren durch die Gestalt des ersten Beinpaars unterscheidet: bei einem ausgewachsenen ♀ des Albatross-Materials (Stat. 4667) ist der

Tarsus fast doppelt so lang als der Metatarsus, während bei einem ebenso grossen aestiva-♀ aus dem Atlantik der Tarsus den Metatarsus nur etwa um die Hälfte seiner Länge übertrifft.

Kap. 9.

Die Gattung Scypholanceola (Woltereck, 1905) und die Bedeutung ihrer "Reflektororgane."

Nach den Exemplaren der Valdivia- und Gauss-Expedition habe ich die Gattung *Scypholanceola* aufgestellt: Lanceoliden, deren Kopf jederseits 2 "*Reflektororgane*" trägt; diese seltsamen, becherförmiges Organe glaubte ich mit den Kopfdrüsen anderer Hyperiden in Beziehung bringen zu sollen, nur dass die vermeintlichen Drüsen hier jede von einer trichterartigen, wallförmigen Erhöhung des Kopfwand umgeben sind. Zwischen dem oberen und dem unteren Trichter springt die Kopfwand scharf leistenförmig vor; und an dieser Stelle, die topographisch dem Augenvorsprung des übrigen Lanceoliden entspricht, fand ich in einem Falle einen dunklen Pigmentfleck, den ich als einen undifferenzierten Augen-rest deutete. Inzwischen bin ich durch das Albatross-Material in die Lage gekommen, noch einige *Scypholanceola*-Köpfe untersuchen und auch präparieren zu können. Dabei stellte sich heraus, dass jener vorspringende, vermeintliche Augenfleck nicht mit dem Gehirn im Zusammenhang steht, dass dagegen die "Drüsen"-Komplexe am Grunde der Trichter von demjenigen Teile des Gehirns reich innerviert werden, welche sonst *das Auge* versorgen.

Die weitere histologische Untersuchung ergab dann die Gewissheit, dass wir es in diesen von mir früher als "Reflektordrüsen" bezeichneten Organen in der That mit höchst seltsam *umgebildeten Augen* zu thun haben, deren optischer Apparat zwar geschwunden ist — es findet sich wie bei den oben als Gruppe b. aufgeführten Lanceoliden keine Spur von Krystallkegeln — die aber zugleich eine höchste auffällige Grössenvermehrung, ja Wucherung erfahren haben. Die Vergrösserung ist erzielt einerseits durch eine Flächenausbreitung der einzelnen Rhabdome (bezw. der gesonderten Rhabdomere) anderseits durch eine riesige Vermehrung der Ommatidien. Topographisch hat das sonst kleine, oval vorspringende Lanceolidenauge sich bei dieser Gattung in folgender Weise verändert: es erscheint bei *Sc. Agassizi* und *Vanhoeffeni* (Fig. 21–22, 24) zu einem flachen Bande ausgezogen, das in der Mitte, wo es am schmalsten ist, rechtwinklig umgebogen ist, sodass die eine Hälfte nach oben, die andere nach vorn gerichtet ist. Beide Enden sind stark verbreitert und nach innen zu (medianwärts) rechtwinklig gegen das schmale Mittelstück umgeknickt. Die beiden verbreiterten Enden des komplizierten Gebildes sind noch dadurch ausgezeichnet, dass das obere muldenartig vertieft, das untere (nach vorn gerichtete) schwach vorgewölbt ist.

Am auffälligsten aber ist die Umgestaltung der seitlichen Kopfwand, die sonst bei allen Lanceoliden ganz konstant eine einfach glatte Oberfläche hat. Die Kopfwand bildet bei *Scypholanceola* um jedes Ende des Augenbandes eine tiefe trichter-artige Nische; die obere dieser Nischen wendet ihre Öffnung schräg nach oben-aussen, die untere dagegen ist nach vorn-seitlich geöffnet. Beide Nischen werden durch einen fast horizontal verlaufenden scharfen Kamm (Fig. 29, *Zro. L.*) getrennt, der durch das Zusammenstossen der unteren Trichterwand der oberen Nische mit der oberen Wandung der unteren Nische entsteht. Das schmale Mittelstück des Augenbandes passiert diesen Kamm nicht, sondern beschreibt einen nach vorn offenen Bogen um das hintere Ende des beschriebenen Kammes. (Siehe Fig. 24.)

Nur bei einen Exemplar meines Materials, einem sehr grossen ♀ (Fig. 23, *Scypholanceola Chuni*) sind die Verhältnisse der beiden Augentrichter sekundär verwischt (jüngere Exemplare zeigen ein dem hier beschriebenen ähnliches Verhalten). Und zwar ist hier das sonst schmale Mittelstück des Augenbandes enorm verbreitert, sodass es an Breite die anderen Augenteile übertrifft. Gleichzeitig ist der untere und in geringerem Grade auch der obere Trichter abgeflacht, sodass eine beinah einheitliche, ausserordentlich ausgedehnte Augenfläche entsteht, welche nach der Seite gerichtet ist. Nur der oberste Teil dieser Fläche ist rechtwinklig nach innen gebogen (also nach oben gerichtet) und von einer flachen Nische umgeben.

Um zu einem Verständniss dieser sonderbaren Augen zu gelangen, müssen wir die Beziehungen kurz aufführen, welche sich von ihnen aus nach verschiedenen Richtungen ergeben.

1. *Die Teilung des Auges in eine nach oben und eine nach der Seite gerichtete Portion* kehrt bei den Phronimiden und andern Hyperiden wieder („Frontauge" und „Seitenauge"). Chun hat gezeigt, dass auch bei andern pelagischen Crustaceen (Schizopoden u. a.) diese Teilung wiederkehrt, deren physiologische Bedeutung darin zu suchen ist, dass die Frontaugen mit ihren verlängerten Krystallkegeln und Rhabdomen für das Wahrnehmen von Bewegungen, die Seitenaugen mit ihren viel kürzeren Elementen für das Erkennen näherer Objekte specialisiert sind.

Wir dürfen aber nicht vernachlässigen, dass wir es hier mit optisch hochausgebildeten Sehorganen zu thun haben, während die „Front- und Seitenaugen" von *Scypholanceola* sowol der Krystallkegel als des Pigments völlig entbehren und auch kaum Unterschiede in der Länge ihrer Elemente erkennen lassen. Vielmehr sind die Sehelemente in beiden Augenabschnitten, insbesondere in deren Randpartieen, flach ausgebreitet.

Immerhin bleibt als tertium comparationis der wichtige Umstand bestehen, dass wir eine weitgehende Trennung einer nach oben gerichteten Portion von einem nach der Seite (bei *Scypholanceola* gleichzeitig nach vorn) gewandten Augenabschnitt vor uns haben.

2. *Die bandartige Anordnung des Auges* steht ebenfalls nicht ganz isoliert da: wir lernten bei der Gattung *Prolanceola* etwas Ähnliches, nur in viel einfacherer Ausführung kennen, indem sich hier an das punktförmige vorgewölbte Auge, das den sämtlichen *Hyperiidea gammaroidea primitiva* gemeinsam ist, eine Reihe von weiteren Augenflecken anschliesst, welche bandartig nach oben zieht (Fig. 14).

Man kann vielleicht aus diesem Befund, der an einer recht ursprünglich gebauten Form [1] gemacht ist, den Schluss ziehen, dass wir es in dem vorgewölbten Punktauge all dieser Formen mit dem Rest eines ursprünglich viel ausgedehnteren Auges zu tun haben, das denjenigen Vorfahren der Lanceoliden eigentümlich gewesen sein mag, die weder halbparasitisch, noch in lichtlosen Tiefenregionen des Meeres lebten.

Wir wären dann des Schwierigkeit überhoben, das *Scypholanceola*-Auge von dem einfachen Augenknopf der anderen *Lanceola*-Arten abzuleiten und könnten uns leichter vorstellen, dass ein bereits vorhandenes Augen*band* sich in dieses komplizierte Gebilde umdifferenziert hätte.

3. Die grösste Schwierigkeit für ein wirkliches Verständniss des *Scypholanceola*-auges liegt in dem Umstand, dass wir es hier einerseits mit einem mächtig entwickelten und hochdifferenzierten Gebilde, anderseits aber mit einem *histologisch rudimentären* Gebilde zu tun haben. Denn die einzelnen Ommatidien dieser Augen bestehen in der That nur mehr aus Retinazellen mit den Rhabdomeren. Sie entbehren jeder Andeutung von Pigment-, Corneal-, und Krystallkegelelementen, dagegen fehlt ihnen nicht eine wolentwickelte Nervenverbindung zum Ganglion opticum.

Die einzelnen Ommatidien stellen flache und breite Gebilde dar, welche vielfach mit den Nachbarzellgruppen verschmelzen. Die Abflachung und Ausbreitung entsteht dadurch, dass die Längsaxen der Sehzellen nicht mehr (wie sonst üblich) in der Einfallsrichtung des Lichtstrahls verlaufen, sondern sich senkrecht zu dieser eingestellt haben. Dabei lässt sich mehr oder weniger deutlich eine Isolierung der Rhabdomere konstatieren, welche dann (Fig. 30a) wie die Finger einer ausgebreiteten Hand neben einander liegen können. Oder auch es sind die Rhabdomere benachbarter Ommatidien verschmolzen, sodass ein zusammenhängendes Netzwerk flach ausgebreiteter Sehelemente sich ergiebt, das einen recht überraschenden Eindruck macht (Fig. 31).

Die dritte Beziehung nun der *Scypholanceola*-Augen, von welcher hier die Rede sein soll, betrifft die Sehelemente von *Lanceola pacifica*. Diese relativ häufige Lanceolide hat einfache in einem kleinen Vorsprung der Kopfseite gelegene Augen, welche entweder den typischen kompakten Bau aufweisen, wie er für rudimentäre Amphipodenaugen charakteristisch ist (Fig. 27), oder aber durch die lockere Anordnung ihres Ommatidien auffallen (Fig. 28). Das Auge entbehrt der Krystallkegel und die distalen Sehzellenabschnitte liegen flach ausgebreitet an der Peripherie. Die Rhabdomere sind in diesem Falle zwar keineswegs von einander getrennt, sondern mit einander teils verschmolzen, teils in einander verschlungen. Immerhin ist auch hier die Tendenz der Sehelemente, sich (nach Verlust der lichtbrechenden Kegel) flach auszubreiten, bezw. senkrecht zum einfallenden Lichtstrahl einzustellen, deutlich zu bemerken. Auch hier ist, wie bei *Scypholanceola*, die histologische Ausbildung der Sehelemente eine gute:

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[1] Ich zeigte schon früher, ehe ich die eigenartige Anordnung der Augen kannte, dass in *Prolanceola vibiliformis* sich Eigenschaften von *Lanceola* mit solchen von *Vibilia* und *Scina* vereinigen.

der Besatz mit "Stiftchensäumen" (Hesse) ist ausserordentlich deutlich.[1] Auch ist die nervöse Verbindung mit dem Centrum sehr kräftig entwickelt. Beides, Stiftchensäume wie Augennerven, ist sogar bei *Lanceola pacifica* sowol als bei den Scypholanceoliden besser ausgebildet als bei den viel weniger rudimentären, nämlich mit Krystallkegeln versehenen Augen der *L. Sayana* und *felina*.

Daraus scheint hervorzugehen, — was ja auch die Grössenentwicklung und "Trichter"-ausbildung beim *Scypholanceola*-auge deutlich zeigt — dass wir hier den Verlust der lichtbrechenden Elemente nicht ohne Weiteres als "*Rudimentär-*" *werden* betrachten dürfen, sondern vielmehr an eine *Funktionsänderung* der Augen bei diesen Tiefseekrebsen denken müssen.

4. Um ein Verständnis dafür anzubahnen, *welchen* Funktionswechsel der Augen wir hier vor uns haben, ist es wünschenswert, auch bei anderen Krebsen eine analoge Veränderung ihrer Augen zu untersuchen. Ich bin in der Lage, auf zwei derartige Fälle hier aufmerksam machen zu können, die beide im Zoolog. Institut zu Leipzig bearbeitet werden. Der eine betrifft die Augen antarktischer Gammariden (Lysianassiden), welche von der Valdivia- und Gauss-Expedition gesammelt und von Herrn cand. Strauss unter Prof. Chun's und meiner Leitung bearbeitet wurden.

Bei der Gattung *Tryphosa* fand Herr Strauss Folgendes: Die Augen sind histologisch rückgebildet, dabei in monströser Weise gewuchert. Fast in der Medianlinie dorsalwärts beginnend, verlaufen sie, sich eng an die Cuticula anschmiegend, bis an die spitzen vorderen Ausläufer des Kopfes, biegen hier nach dem Munde zu um und erstrecken sich sogar noch ein Stück in das Epistom hinein (Fig. 32 a). Sehr auffällig ist nun, dass die Augen caudalwärts sich sogar ein beträchtliches Stück unter die gewaltig entwickelten Mandibularmuskeln schieben (Fig. 32 b). Bei den einzelnen Individuen erstreckt sich diese Wucherung verschieden weit nach hinten; bei einem Exemplar erreichte das Auge das erste Brustsegment.

Die Krystallkegel sind auch bei diesem Auge vollständig geschwunden, dagegen sind die 5 Retinazellen, ihre Nervenfortsätze und vor allem die Rhabdome gut ausgebildet. Die vielfach gewundenen Rhabdomere lassen einen doppelseitigen Besatz mit Stiftchen erkennen.

Ueber die Details dieser eigentümlichen Augen wird Herr Dr. Strauss in den Ergebnissen der Valdivia-Expedition berichten; uns interessiert hier nur, dass wir in einem zweiten Fall ein Amphipoden-Auge vor uns haben, das *einerseits mächtig entwickelt, ja gewuchert ist* (bis in das Epistom und bis unter die Muskulatur) *und das andrerseits aller lichtbrechenden Elemente entbehrt*, während die rezeptiven Elemente gut ausgebildet sind.

Tryphosa ist ein Krebs, der in Massen unter dem Eise am Grunde der antarktischen Küstenmeere lebt. Ein dritter Fall, der noch mehr hierher zu gehören scheint, betrifft wiederum pelagische Tiefseekrebse, und zwar Ostrakoden der Gattung *Gigantocypris*, deren Augen von Herrn Lüders im Leipziger Institut untersucht wurden und folgende Eigentümlichkeiten zeigen (vergl. Fig. 33;

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[1] Für einige weitere Details vergl. die Figurenerklärung zu Tafel VIII.

eingehende Beschreibung in der Zeitschrift für wissenschaftliche Zoologie, 1908).

Das Medianauge von *Gigantocypris* setzt sich aus 3 Teilen, einem kleinen mediangelegenen Abschnitt und *2 grossen lateralen Augenbändern* zusammen. Die letzteren interessieren uns hier besonders. Sie sind nämlich jedes von einem mächtigen Reflektor umgeben, der braun pigmentiert ist und im Leben perlmutterartig glänzt.

Der Reflektor ist zwar (im Gegensatz zu *Scypholanceola*) für jedes der beiden Seitenaugen einheitlich, aber dieses stellt wie in unseren Falle ein gebogenes Band dar, an dem *zwei Endanschwellungen* und ein schmales Mittelstück zu unterscheiden sind. Während das obere "birnförmige" Stück voll nach vorn gerichtet ist und fast im Mittelpunkt des Reflektors liegt, erscheint das untere "dreieckförmige" Stück, das zur Hälfte ausserhalb des Reflektors gelegen ist, mehr nach der Seite gewandt.

Diese Augen entbehren aller linsenartigen Bildungen, sie stellen nur eine mächtigentwickelte Retina dar, die aus zahllosen schmalen parallelen Zellen besteht. Die Zellränder lassen eine undeutlich gestreifte Differenzierung erkennen, welche vielleicht den Stiftchensäumen entspricht.

Die Vergleichspunkte des *Gigantocypris*-Auges mit dem von *Scypholanceola* sind folgende: in beiden Fällen haben wir mächtig entwickelte, bandförmige, in einen oberen und unteren Abschnitt differenzierte Augen vor uns, welche zwar des lichtbrechenden Elemente entbehren, die receptiven Elemente aber in überreicher Ausbildung zeigen. Als Hilfsapparate finden wir in beiden Fällen Nischen- oder Reflektor-artige Cutikularbildungen des Kopfes, wobei es kein prinzipieller Gegensatz zu sein braucht, dass diese Reflektoren bei *Gigantocypris* für jedes Augenband einheitlich sind, während *Scypholanceola* jederseits zwei Reflektoren, für jede Endanschwellung des Augenbandes eine, aufweist.

. . . .

Eine physiologische Deutung dieser Augenformen begegnet grossen Schwierigkeiten; sicher scheint mir aber zu sein, dass wir für die drei beschriebenen Fälle eine gemeinsame Deutung suchen müssen, nicht nur für die Augen der beiden Amphipoden *Tryphosa* und *Scypholanceola*, sondern ganz besonders für die beiden sich verwandtschaftlich so fern stehenden Bewohner der pelagischen Tiefenzone: für den Ostrakoden und den Amphipoden.

Wenn wir den ganzen Erscheinungskomplex zusammenfassen, so finden wir vier Veränderungen des normalen Augentypus, welche eine Erklärung verlangen:

1. Die lichtbrechenden Elemente (und die Augen-Pigmente) sind geschwunden;
2. das Auge ist excessiv vergrössert, die receptiven Elemente sind überreich entwickelt;
3. das Auge ist in zwei verschieden gerichtete Abschnitte (nach oben und nach der Seite, bezw. nach vorn und nach der Seite) geteilt;
4. um das Auge sind Reflektor-artige Cuticularbildungen entwickelt.

ad 1. Diese Veränderung, die bei so vielen Tiefseekrebsen (z. B. Brachyuren) wiederkehrt, lässt sich dadurch erklären, dass bei sehr geschwächtem Licht eine noch so reduzierte Bilderzeugung nicht mehr möglich war und deshalb die Linsenbildungen als nicht mehr nützlich allmählich in Fortfall kamen.

ad 2. und 3. Diese Vergrösserung und Differenzierung der nunmehr nur noch receptiven Augenelemente kann *vielleicht* dadurch erklärt werden, dass die Augen für *schwache* Lichteindrücke, insbesondere für sich bewegende Lichtpunkte (Leuchtorgane der Feinde und Beutetiere) brauchbar und deshalb selektionswertig blieben. Der Schwund der lichtbrechenden Teile bleibt dann allerdings schwer verständlich.

ad 4. Die *Reflektor*-bildungen geben uns einen Hinweis, dass doch noch etwas anderes im Spiele sein muss bei dieser mächtigen Ausbildung optisch rudimentärer Augen. Ich vermute vorderhand, dass diese Augen kleine Lichtmengen, welche sie von den Leuchtorganen anderer Tiere (oder als Dämmerlicht von oben her) treffen, verstärkt *reflektieren,* um dadurch Beute anzulocken oder Feinde abzuschrecken. Das Reflektieren wird zunächst eine belanglose Nebenerscheinung gewesen sein, wie etwa das "Augenglühen" vieler Tiere in der Dämmerung.

In unseren Falle wird die Erscheinung vielleicht durch die gewucherten Rhabdome und zwar im Besondern durch die zahllosen, parallel geschichteten und ziemlich stark "glänzenden" (d. h. reflektierenden) Stäbchen verursacht, welche die "Stiftchensäume" zusammensetzen.

Man kann sich einmal vermutungsweise vorstellen, dass die Gesamtheit dieser Elemente, die zu einem *flach ausgebreiteten* Netzwerk werden Können, ein Aufleuchten oder Flimmern zeigt, wenn sie von Lichtstrahlen getroffen wird, die etwa von den Leuchtorganen eines Fisches oder Krebses ausgehen. Dieses Aufleuchten mag dann eine Verstärkung in den reflektorartigen Cutikularbildungen der Kopfwand finden.

So sehr diese Hypothese der (leider sehr erschwerten) Prüfung am lebenden Objekt bedarf, scheint sie mir doch die einzige Annahme zu sein, welche die rätselhaften Reflektorbildungen und gleichzeitig die flache Ausbreitung der gewucherten Rhabdome einigermassen verständlich erscheinen lässt.

Die Orientierung des *Scypholanceola*- (und in geringerem Grade auch des *Gigantocypris*-) Auges *in verschiedene Ebenen* kann vielleicht damit erklärt werden, das, auf diese Weise einerseits nach verschiedenen Richtungen Licht reflektiert wird und dass andrerseits Lichtstrahlen verschiedener Einfallsrichtung verwertet werden können.

. . . .

Es erübrigt noch, die mir vorliegenden Exemplare von *Scypholanceola* systematisch zu unterscheiden.

Auffällig ist der Umstand, dass die Unterschiede, welche diese Gattung von den übrigen Lanceoliden trennen, zwar sehr tiefgreifende sind, soweit der Kopf in Betracht kommt, aber geringfügige in Bezug auf den übrigen Körper und die Gliedmassen. Ebenso sind auch innerhalb der Gattung sehr erhebliche Unterschiede im Bau des Kopfes, speciell der Augenregion zu bemerken, aber im übrigen Körperbau sind nur recht geringe Differenzen vorhanden. Da indess diese Unterschiede sich bei beiden Geschlechtern finden und bereits von sehr jungen Stadien an vorhanden sind, so ist die Aufstellung mehrerer Arten unerlässlich.

Bestimmungstabelle.

Genus *Scypholanceola.* — Von der benachbarten Gattung *Lanceola* unterschieden durch die Umbildung der Augen zu umfangreichen Bändern und durch das Auftreten von je zwei die Enden jedes Augenbandes reflektorartig umgreifenden Bechern an den Kopfseiten. Sonst mit den Merkmalen der Gattung *Lanceola.*

a. Augenband in der Mitte am breitesten, Becher flach und breit. Unterer und oberer Teil der Augen durch eine scharfe, aber niedrige Leiste getrennt. . . . . Species 1: *Sc. Chuni.*
(bisher im *Atlantik* gefunden, reifes ♀ auf Station 50 der Valdivia-Expedition [Fig. 23]).

b. Augenband in der Mitte am schmalsten, und hier in einem nach vorn-oben offenen Winkel umgebogen. Enden des Augenbandes von deutlich ausgeprägten Bechern umgeben. . . . . Species 2 und 3:
Augenband in der Mitte weniger als halb so breit als in den Endflächen. Diese sind von stark gewölbten Bechern (Reflektoren) umgeben. Die beiden Becher jeder Seite sind durch einen schmalen, steil gewölbten Kamm getrennt; kräftiges Rostrum. . . Species 2: *Sc. Vanhoeffeni.*
(bisher im *Antarktik* und *Indik* gefunden, reifes ♂ der Gauss-Expedition vom 10. III. 03. [Fig. 24 a], reifes ♀ des Valdivia-Expedition, Stat. 239 [Fig. 24 b]).

c. Augenband in der Mitte mehr als halbsobreit als in den Endflächen. Diese sind von flach gewölbten, kleinen Bechern (Reflektoren) umgeben. Die beiden Becher jeder Seite sind durch einen breiten, flach gewölbten Kamm getrennt; Rostrum nur angedeutet. . . . Species 3: *Sc. Agassizi.*
(bisher im *Pacifik* gefunden, Männchen von Station 4673 der Albatross-Expedition [Fig. 21–22]).

Zu der neuen pacifischen Art des Albatross-Materials, *Scypholanceola Agassizi*, möchte ich noch bemerken, dass sie wesentlich kleiner als die atlantische und die antarktisch-indische Species zu bleiben scheint. Das grösste ♂ ist mit 17 mm. Länge nur wenig mehr als halb so gross als das ♂ von *Sc. Vanhoeffeni* und nur ein Drittel so gross als das ♀ von *Sc. Chuni.* Dennoch ist es, nach dem Entwicklungzustand seines Gehirns und der Körperanhänge zu schliessen (die Gonaden waren leider durch Maceration zerstört), annähernd reif. Diese Art unterscheidet sich auch dadurch von den beiden andern Arten, dass der Kopf höher und schmaler, die Stirnfläche kleiner ist als bei jenen; endlich sind die oberen Becher höher am Kopf angebracht als bei den anderen Arten.

Schwierig ist es, die Jugendstadien von *Scypholanceola* richtig zu identificieren. Doch fanden sich junge Tiere sowol mit ganz flachen Bechern und einheitlichem Augenband (*Sc. Chuni*) als auch mit sehr tiefen und durch einen scharfen Kamm getrennten Bechern (*Sc. Vanhoeffeni*). Die vom Albatross aus dem Pacifik erbeuteten Jugendstadien endlich erinnern durch ihre hohen schmalen Köpfe und durch die Form ihres Augen und Becher an das skizzierte ♂ von *Sc. Agassizi.* Leider sind grade diese wichtigen Jugendstadien wenig gut erhalten. — Es ist zu hoffen, dass ich vor dem Abschluss meiner Lanceoliden-bearbeitung noch in den Besitz weiterer, sorgfältig konservierter Stücke gelange.

TAFEL I.

FIG. 1. Maxillipeden von *Gammarus locusta.* (Nach G. O. Sars. Crustacea of Norway. Vol. 1, Pl. 1.) *i. l.* Innenlade des 2. Gliedes, *a. l.* Aussenlade des 3. Gliedes.

FIG. 2. Maxillipeden eines pelagischen Gammariden. Glied 4–7 erscheint bereits als tasterartiger Anhang der Aussenladen.

FIG. 3. Maxillipeden des Gammariden *Lafystius Stationis.* (Nach Della Valle: Flora und Fauna des Golfes von Neapel, Bd. 20, Taf. 40, Fig. 1.) Taster auf 2 Glieder reduziert.

FIG. 4. Maxillipeden von *Sphaeromimonectes Valdiviae* ♂ subsp. *pacifica* mit eingliedrigem Rudiment des Tasters und völlig getrennten Innenladen. Echte Uebergangsform zwischen den *Gammaridea genuina* (Fig. 1–3) und den *Hyperiidea genuina* (Fig. 5).

FIG. 5. Maxillipeden von *Hyperia galba* (Mont.) ♀ (nach G. O. Sars: Crustacea of Norway, 1895, Vol. 1, Pl. 2) als Typus der *Hyperiidea genuina.* Ohne Taster und mit vollständig zu einen Medianlobus verschmolzenen Innenladen.

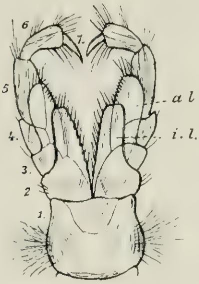
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Fig. 1.

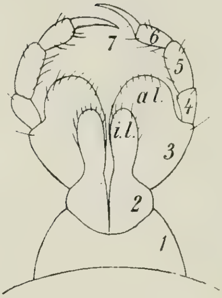
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Fig. 2.

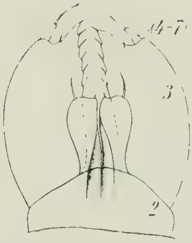


Fig. 4.

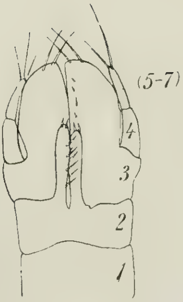


Fig. 3.

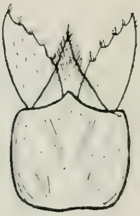


Fig. 5.

Dr. Strauss et Woltereck del.

TAFEL II.

Fig. 6. *Sphaeromimonectes Valdiviae pacifica,* subsp. nov. ♂.

Der Körper ist schlank, nicht aufgetrieben, Kopf und Peräon-segmente gleichmässig lang. Ventralkontur (punktiert) verläuft konkav. Charakteristisch für die Species ist die Form des zweiten Beinpaars und die Stirnlinie (*St. l.*) vor den *Scina*-ähnlichen ersten Antennen. *T.*, Testis. Das dritte Brustbein, das dem vierten genau gleicht, ist fortgelassen, ebenso die Kiemenanhänge. Vergr. 10 ×.

Fig. 7. *Sphaeromimonectes Valdiviae* (forma typica) ♀.

Peräonsegmente dorsal und ventral stark aufgebläht. Kiemen und Brutplatten fortgelassen. Vergr. 4 ×.

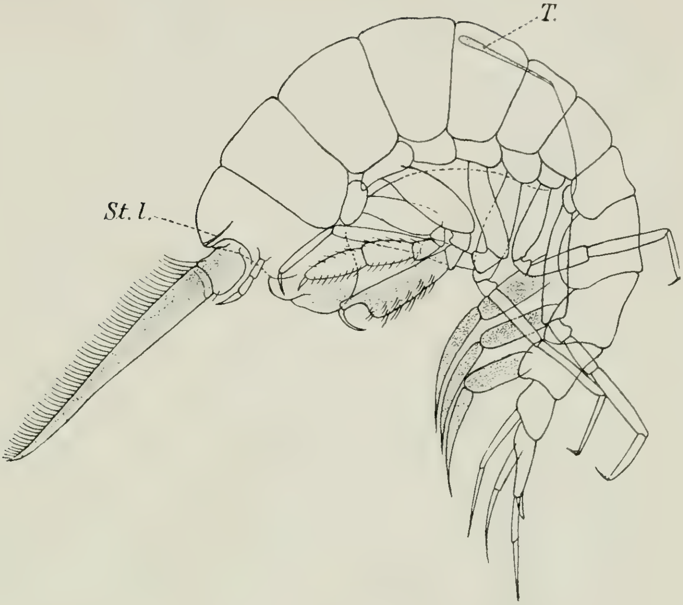


Fig. 6.

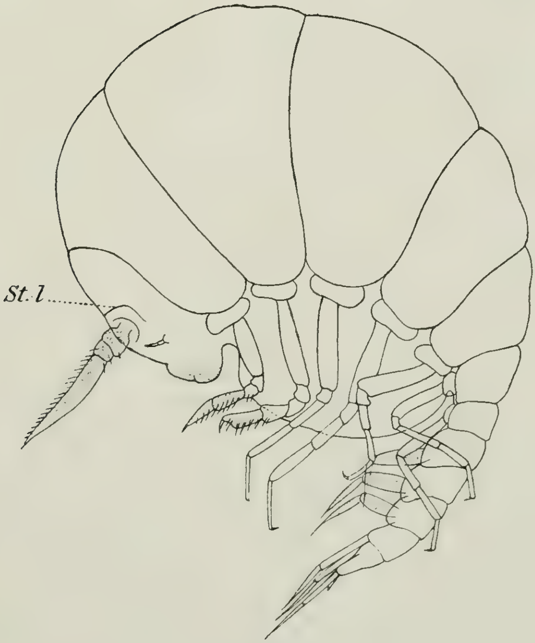


Fig. 7.

Wolterecl: del.

TAFEL III.

Fig. 8. *Sphaeromimonectes Diomedeae*, sp. nov.

An den Peraeon-segmenten fallen schräg verlaufende Leisten auf, welche zur Verstärkung des ohnehin ziemlich derben Integuments dienen. Das vierte Brustbein, das dem dritten völlig gleicht, ist fortgelassen, ebenso die Kiemen. Vergr. 8 ×.

Fig. 9. *Chuneola paradoxa*, gen. et sp. nov. Aus dem Material der Valdivia-Expedition.

Das zweite Brustbein fehlt. Am dritten bis siebenten Brustbein rückziehbare Dactyli. Kiemen fortgelassen. Vergr. 10 ×.

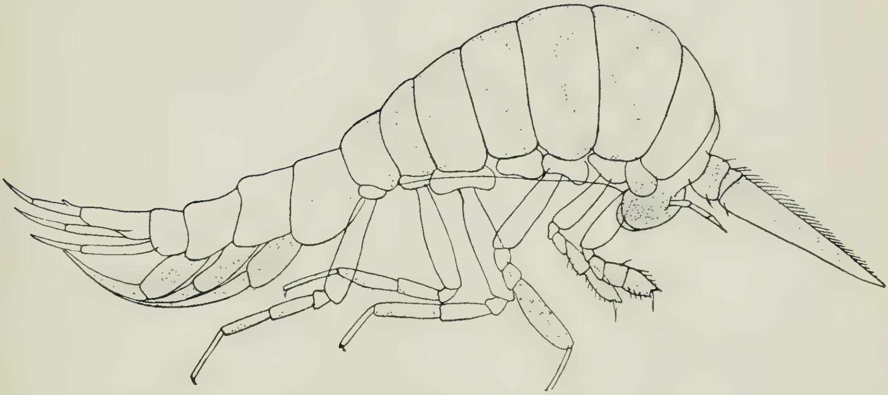


Fig. 8.

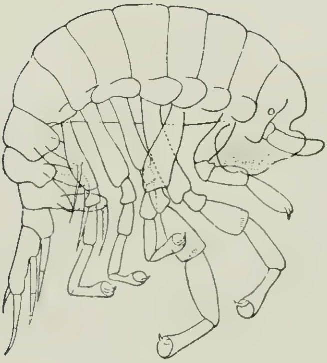


Fig. 9.

Woltereck del.

TAFEL IV.

Fig. 10. *Mimonecteola Diomedeae*, gen. et sp. nov.

Der Magendarm ist mit Nesselkapseln gefüllt. Körperform und Antennen *Lanceola*-ähnlich, Peräopoden durch das Fehlen rückziehbarer Dactyli und durch die Anschwellung der Tarsen (bei sehr schmalen Metatarsen) charakterisiert. Erstes Brustsegment wenig länger als der Kopf. Vergr. 10 ×.

Fig. 11. *Microphasma Agassizi*, gen. et sp. nov.

Charakterisiert durch die stark aufgeblähte Form des 2.–4. Peräonsegments, die *Vibilia*-artigen Antennen des sehr hohen Kopfes und vor allem durch die auffallend kräftigen Metatarsen des 3.–5.

Beinpaars, deren Dactyli zangenartig eingeschlagen werden. Vergr. 17 ×.

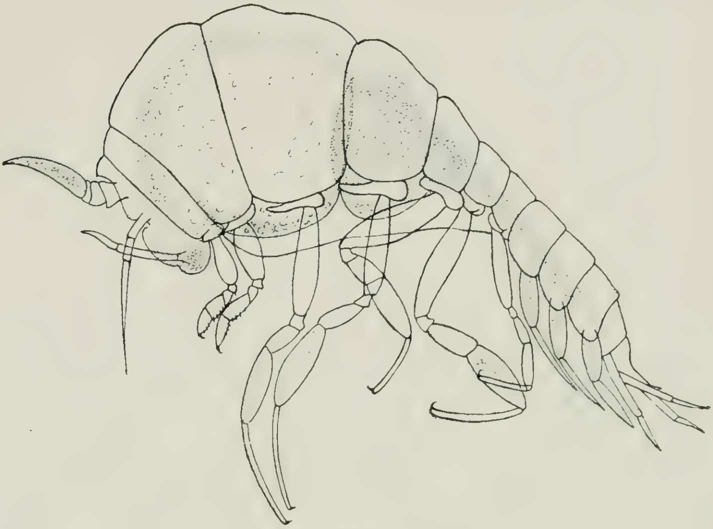


Fig. 10.

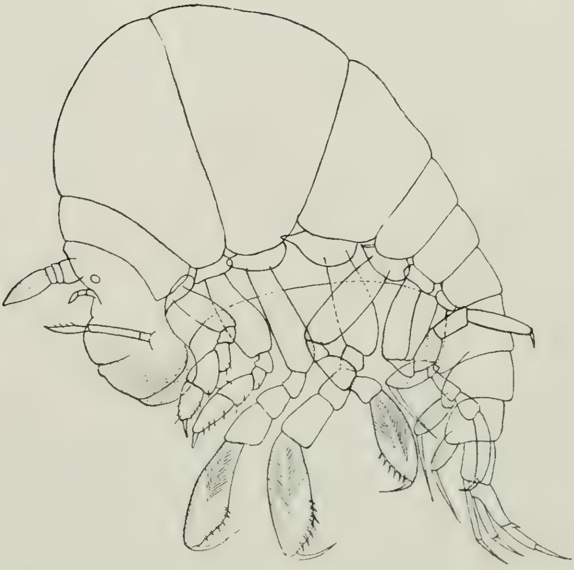


Fig. 11.

Woltereck del.

TAFEL V.

Fig. 12. *Micromimonectes Irene* ♀. Die Eier liegen in einer Bruttasche. Kiemen fortgelassen. Vergr. 16 ×.

Fig. 13. *Archaeoscina Stebbingi*, sp. nov.
Unreifes Exemplar. Das 4. Brustbein, das dem dritten genau gleicht, ist fortgelassen, ebenso die Kiemen. Vergr. 20 ×.

Fig. 14. *Prolanceola vibiliformis* ♀ aus dem Pacifik. Charakteristisch für die Art ist die eigentümliche Greifhand des ersten Beinpaars und das fünfte Beinpaar mit sehr langer Tibia und ganz kurzem Metatarsus. 5.–7. Beinpaar mit rückziehbaren Klauen. Ueber dem vorspringenden Auge eine Reihe von weiteren Augenflecken. Erste Antennen zweigliedrig Brutplatten und Kiemen fortgelassen. Vergr. 8 ×.

Fig. 15. ♂ dazu aus dem Indik (Valdivia-Expedition). Erste Antennen 4-gliedrig. *T.*, Hoden. Kiemen fortgelassen. Vergr. 10 ×.

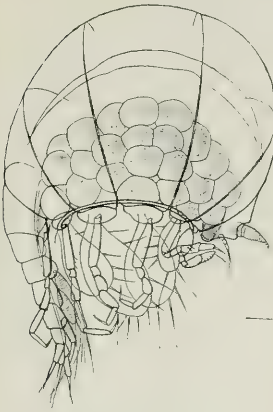


Fig. 12.

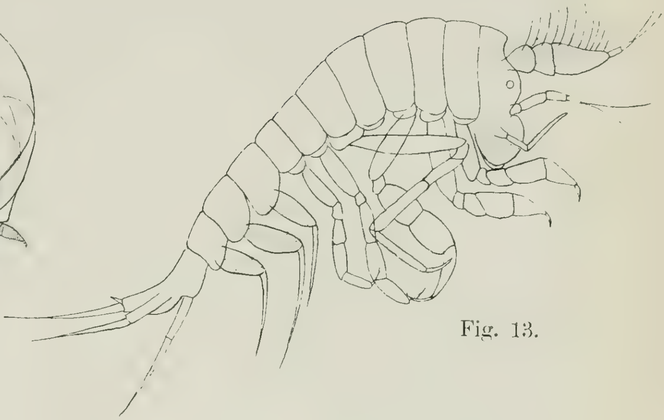


Fig. 13.

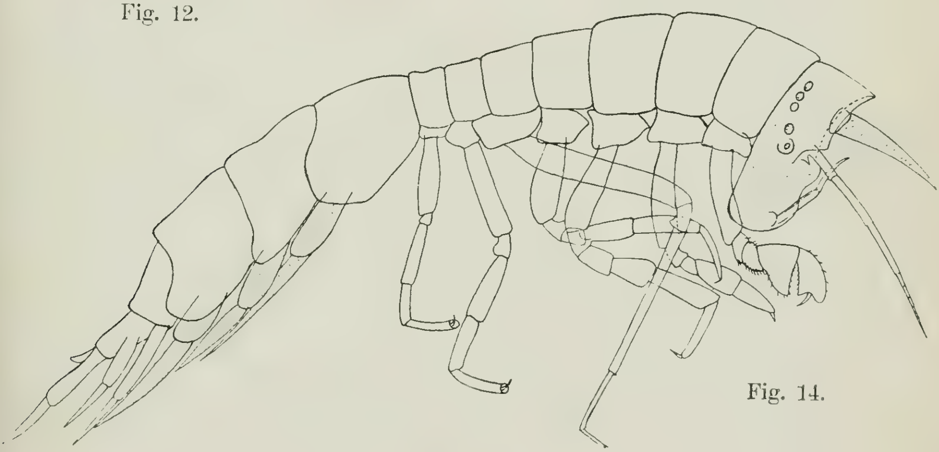


Fig. 14.

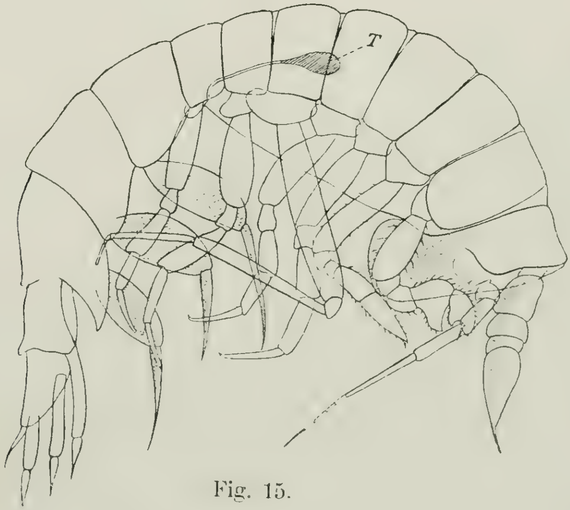


Fig. 15.

Woltereck del.

TAFEL VI.

FIG. 16. *Lanceola Sayana longipes*, subsp. nov. aus dem Pacifik. Das dritte Beinpaar, das dem zweiten genau gleicht, fortgelassen, ebenso Brutplatten und Kiemen. Vergr. 8 ×.

FIG. 17. *L. Sayana*, forma *typica* (nach Bovallius). Zum Vergleich mit der vorigen Subspecies.

FIG. 18. Köpfe von vorn gesehen, *a.* forma *typica*, *b.* subspecies *longipes* von *L. Sayana.*

FIG. 19. Endglieder der ersten Antennen des ♀ von *L. Sayana* (für forma *typica* und subspecies *longipes* gleich).

FIG. 20. Dasselbe für *Lanceola felina* (*typica* und *longipes*), um den Unterschied der Antennen beider Arten zu zeigen.

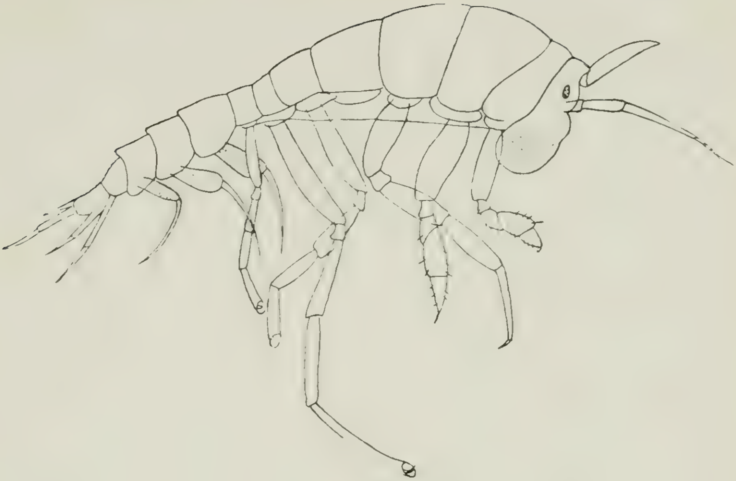


Fig. 16.

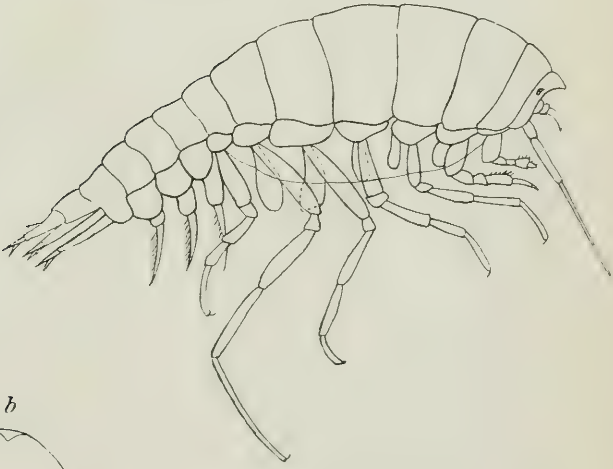


Fig. 17.

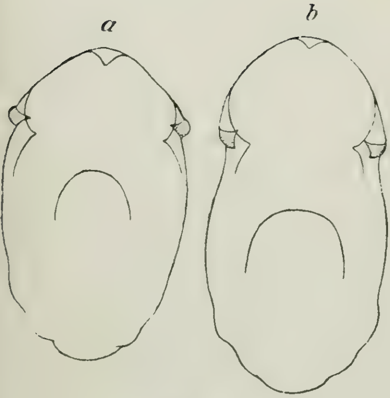


Fig. 18.

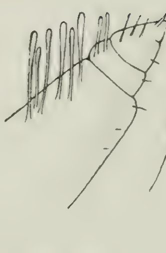


Fig. 19.

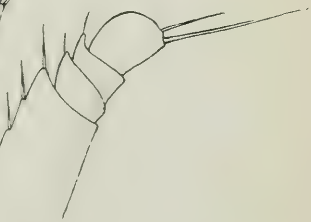


Fig. 20.

Woltereck del.

TAFEL VII.

FIG. 21. *Scypholanceola Agassizi*, sp. nov. Das vierte Brustbein, das dem dritten genau gleicht, ist fortgelassen, ebenso die Kiemen. Vergr. 6 ×.

FIG. 22. Kopf derselben Art bei stärkerer Vergrösserung. Man erkennt die zwei Augenbecher („Reflektoren") einer Kopfseite, ferner das „Augenband," welches beide verbindet und welches in jedem Becher medianwärts scharf umbiegt. Diese beiden Enden des Augenbandes sieht man demnach von der Seite her im Querschnitt. Sie erscheinen deshalb dunkel. (In Fig. 22 schwarz, das „Augenband" punktiert.) Kopf ohne Rostrum.

FIG. 23. Oberer Kopfteil von *Scypholanceola Chuni*, sp. nov., von der Seite gesehen. Das „Augenband" bildet eine breite Fläche. Der obere Augenbecher ist flach, aber deutlich ausgeprägt, der untere ist weniger deutlich, aber er ist scharf durch die schräg verlaufende Zwischenleiste von dem übrigen Teil des Augenbandes getrennt. (Material der Valdivia-Expedition.)

FIG. 24. *Scypholanceola Vanhoeffeni*, sp. nov. Augenbecher, Zwischenleiste und Augenband (punktiert) sehr deutlich ausgeprägt. a. ♂ (Material der Gauss-Expedition). b. ♀ (Material der Valdivia-Expedition.)

FIG. 25. Kopf einer jugendlichen *Scypholanceola* von vorn gesehen, um das Lageverhältniss der unteren und oberen Augenbecher deutlicher zu machen. Die letzteren erscheinen als tief eingesenkte Trichter hinter den flacheren, ovalen unteren Bechern, in welche man von vorn hineinsieht.

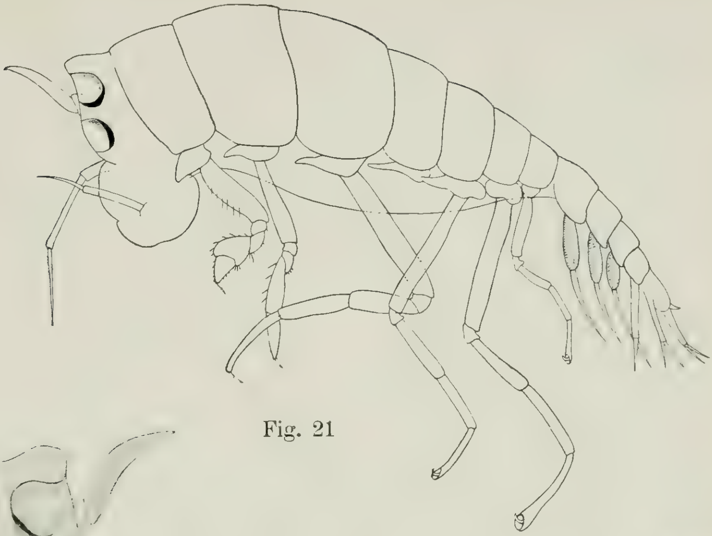


Fig. 21

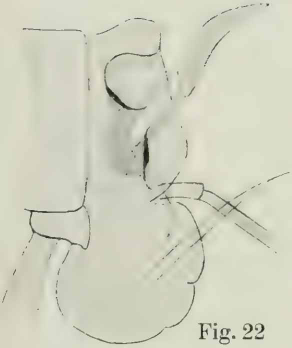


Fig. 22

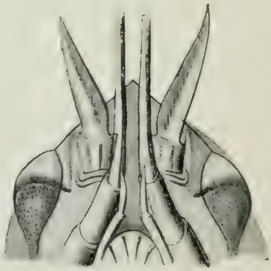


Fig. 25

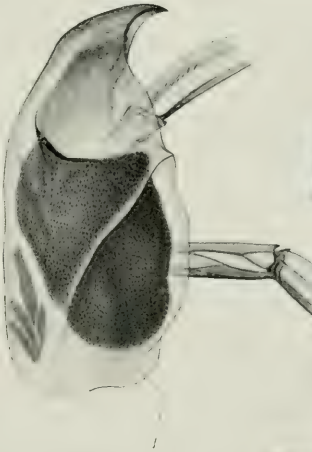


Fig. 23

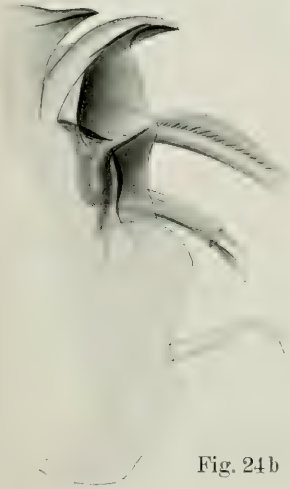


Fig. 24 b

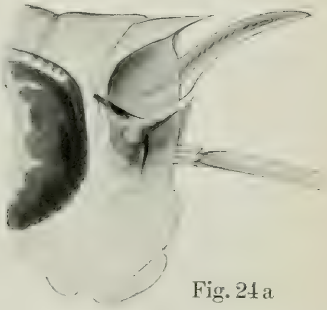


Fig. 24 a

Dr. Etzold et Woltereck del.

TAFEL VIII.

Fig. 26. Auge von *Lanceola Sayana* (Exemplar aus dem Pacifik). Längsschnitt (a) und Querschnitt (b) durch einige Ommatidien. Diese sind in der bei marinen Gammariden häufigen Art in einen kompakten distalen Abschnitt ("Augenkeil" Strauss) und in die fadenförmigen Proximalabschnitte der fünf Retinulazellen gesondert. Vor dem Augenkeil liegt bei dieser Art der zweiteilige Krystallkegel (Kr. K.). In Fig. 26 b sind drei "Augenkeile" quer geschnitten, um die typische Anordnung der "Stiftchensäume" an den Innenseiten der fünf Retinulazellen zu zeigen.

Fig. 27. Längsschnitt durch das Auge einer jungen *Lanceola pacifica.*

Die freiverlaufenden Fadenteile der Retinulazellen mit ihren Kernen treten deutlicher hervor. Vor dem würfelförmigen Augenkeil sind noch die Kerne der Krystallkegelzellen (*Kr. K. Z.*) sichtbar; Krystallkegel fehlen.

Fig. 28. Auge eines grossen *Lanceola pacifica*-♀ a. Totalpräparat, ungefärbt. Die Augenkeile sind flach ausgebreitet, die Retinulazellen mit ihren "Stiftchensäumen" sind mannigfaltig mit einander verknäuelt.

b. Längsschnitt durch zwei Ommatidien; es sind die Fadenteile von je 3 Retinulazellen getroffen. (b. und c. Heidenhain-Färbung.)

c. Querschnitt durch den basalen Teil von drei "Augenkeilen." Die gewucherten Stiftchensäume treten deutlich hervor, das Plasma der Retinulazellen ist auf ganz schmale Leisten reduziert (schwarz). Die weiss erscheinenden Zwischenräume entsprechen *nicht* (wie es den Anschein hat) dem Zellkörper der Retinulazellen in Fig. 26 b, sondern sind Lücken, welche zwischen den Windungen der verlängerten Rhabdomere entstanden sind.

Fig. 29. *Scypholanceola Agassizi*, Schnitt durch die beiden Augenbecher einer Kopfseite, um die Anordnung des oberen (*o. Tr.*) und unteren (*U. Tr.*) Trichters und der Zwischenleiste (*Zro. L.*) zu zeigen. Am Grunde der Trichter Retina-Teile ("Augenband," vergl. Fig. 22 u. 24). Die Ommatidien sind nicht deutlich voneinander getrennt, die Retinulazellen nicht in "Keil" und Fadenteil gesondert. Augennerv deutlich.

Fig. 30. a. Totalpräparat von drei Ommatidien aus der Randpartie eines Bechers von *Scypholanceola* juv. Die einzelnen Retinulazellen sind selbständig entwickelt und auf der Trichterwandung flach ausgebreitet.

b. Schnitt senkrecht durch die Trichterwandung und durch drei solche Retinulazellen geführt. Stiftchensäume ausserordentlich deutlich. Zelle *1* ist nahe am distalen Ende, Zelle *2* und *3* mehr proximalwärts getroffen.

Fig. 31. Totalpräparat eines Augenabschnitts von *Scypholanceola Agassizi.* Die Rhabdomere und Stiftchensäume benachbarter Retinulazellen sind zu einem (lichtreflektierenden?) Netzwerk verschmolzen.

Fig. 32. Auge eines unter dem Eise lebenden Gammariden *Tryphosa kergueleni* Miers, dessen Augen wie die von *Scypholanceola* einerseits stark vergrössert sind, andrerseits der lichtbrechenden Elemente entbehren. Nach Strauss.

a. Die Augen wuchern medianwärts in das Epistom hinein.

b. Die Augen wuchern nach hinten bis unter die Kaumuskulatur.

Fig. 33. *Gigantocypris Agassizi* (Müller), ein pelagischer Tiefsee-Ostrakode, wie *Scypholanceola* mit zweiteiligen "Augenbändern" und Reflektoren. (Nach Chun und Lüders.) Vergl. Text S. 165.

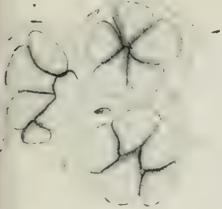


Fig. 26 b

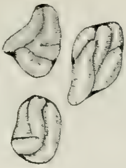


Fig. 28 c

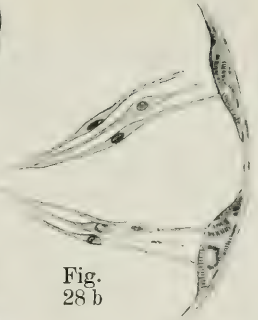


Fig. 28 b

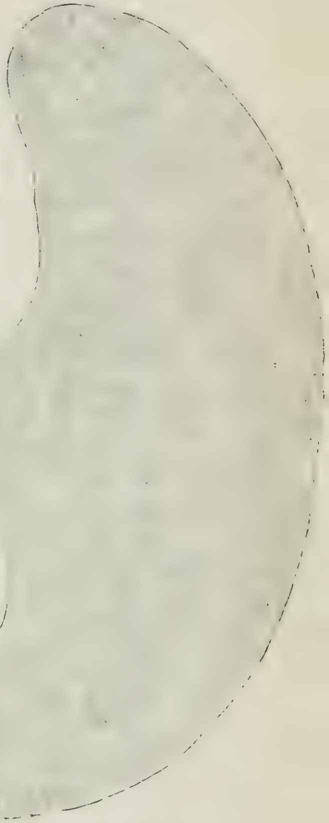


Fig. 28 a

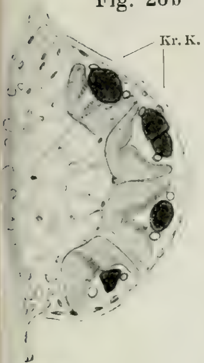


Fig. 26 a

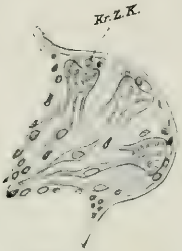


Fig. 27

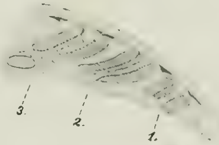
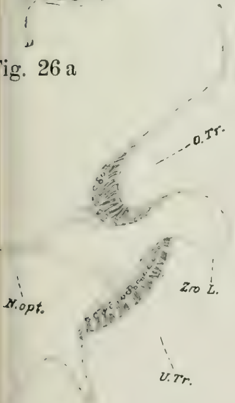


Fig. 30 b


o. Tr.
N. opt.
Zw L.
U. Tr.
Fig. 29

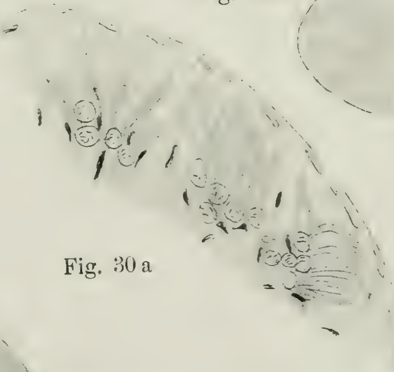


Fig. 30 a

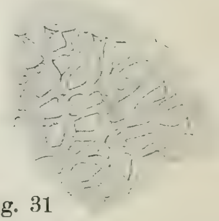


Fig. 31

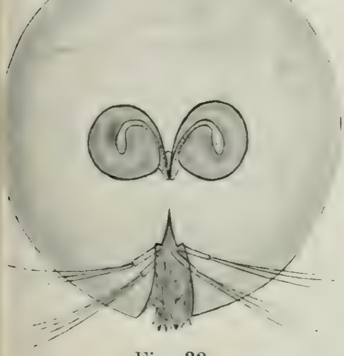
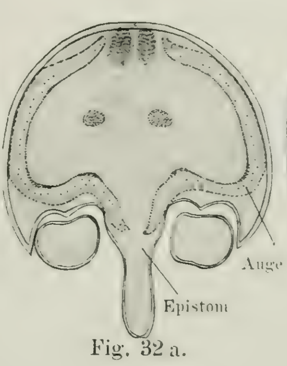
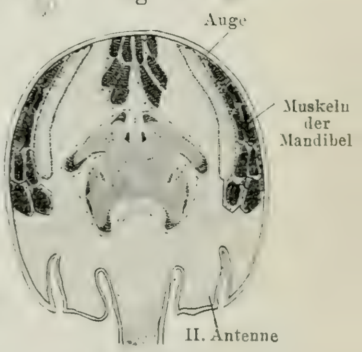


Fig. 33


Auge
Epistom
Fig. 32 a.


Auge
Muskeln der Mandibel
II. Antenne
Fig. 32 b.

Dr. Strauss et Woltereck del.

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NOTES ON THE PHYTOPLANKTON OF VICTORIA NYANZA, EAST AFRICA.

By C. H. Ostenfeld.

With Two Plates.

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No. 10. *Notes on the Phytoplankton of Victoria Nyanza, East Africa.* By C. H. Ostenfeld.

1. General Remarks.

From Dr. Alexander Agassiz I received some few plankton samples from Lake Victoria Nyanza, East Africa, with the request to examine their microflora. As I have, quite recently, published a paper on the same subject I agreed with pleasure to the proposal, and I extend to Dr. Agassiz my sincere thanks for placing this material at my disposal and for giving me permission to illustrate it so richly.

The samples in question were collected on the 21st and 23d of February, 1908, respectively, and their main interest lies in this early date, as the knowledge of the plankton of this large lake hitherto has been based upon collections from April (1905, Dr. Cunnington), October (1892, Dr. Stuhlmann), and November (1904, Dr. Borgert); furthermore the earlier collections were from places in the northern and western parts of the lake[1], while Dr. Agassiz's samples were taken in the harbor of Mwanza and off Shirati, both places on the southern shore of the lake.

I have had five samples at my disposal, but as they are from only the two localities just mentioned, I prefer to take them as corresponding to but two numbers. I do not know with certainty the number of silk gauze used, but I have been informed that it is rather wide-meshed, which perhaps may explain, to some degree, the scarcity of some of the smaller phytoplanktonts.

The above given dates of earlier plankton collections show how little we know the plankton of Victoria Nyanza. The few (7) samples collected by Dr. Stuhlmann in 1892 have been examined — with regard to the phytoplankton of which only I speak here — by Prof. W. Schmidle[2]; three samples from the third British Tanganyika Expedition of 1905 have been published, together with the examination of the phytoplankton from Lake Nyassa and Lake Tanganyika by Mr. G. S. West[1]; and the few (7) samples brought home by Dr. A. Borgert in 1904 have been worked out by me in the paper mentioned above where I[2] have put together all the few data on the phytoplankton of Victoria Nyanza and have compared them with the statements of the phytoplankton of Lake Nyassa[3].

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[1] As to the collection made by Dr. Stuhlmann, it was taken "an verschiedenen Stellen des Sees."

[2] Schmidle, W., Botan. Jahrb., 1898, **26**, p. 1–59, pl. 1–4; 1902, **33**, p. 1–33.

Referring to this paper I quote some of its main results: —

"The phytoplankton of Victoria Nyanza and Lake Nyassa bear a great resemblance to each other, the dominant species being the same in both lakes. Both lakes are characterized by rare tropical species, some of which are common to both lakes, others of which are restricted to one of them.

"In spite of their extensive areas the lakes contain a phytoplankton which must be spoken of as a pond plankton ('lac-étang' plankton, in *Chodat's* sense), not as a true lake plankton, and the tycholimnetic species play a great part in the composition of the plankton.

"The phytoplankton of Victoria Nyanza itself is characterized by Microcystis, Anabaenae, Lyngbyae, Melosirae, Surirellae, Cymatopleurae, Nitzschiae, numerous Protococcales, and many Desmidiaceae (especially Staurastrum species); it is richer in species than that of Lake Nyassa, especially through the occurrence of many Desmids."

As to the seasonal changes in the composition of the plankton our knowledge is too limited to say anything more definite, but in this particular respect the two samples collected in February by Dr. Agassiz are interesting, as compared with the samples later in the year from April, October, and November; they show that *the Diatoms* (especially Melosira) *are dominant in the early spring, while later in the year the Green Algae and Blue-green Algae reach their maximum.* This change corresponds to the normal changes in the composition of the lakes in the lowland of the temperate Europe ("The Baltic Fresh-water Plankton," of C. Wesenberg-Lund).[4] In my paper I have suggested something in this way in saying of the samples from April collected by Dr. Cunnington (*l. c.*, p. 344): "nur treten die Schizophyceen (Myxophyceen) in diesem Frühjahrs-Plankton zurück." But it is not until we have the still earlier samples collected by Dr. Agassiz that we may be justified in drawing a conclusion concerning the seasonal change and its resemblance to the seasonal changes of the "Baltic fresh-water plankton."

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[1] West, G. S., Journ. Linnean Soc. London, Botany, 1907, **38**, p. 81–197, pl. 2–10.

[2] Ostenfeld, C. H., Botan. Jahrb., 1908, **41**, p. 330–350.

[3] See Schmidle, W., Botan. Jahrb., 1899, **27**, p. 229–237; 1901, **30**, p. 240–253, pl. 4–5; 1902, **32**, p. 56–88, pl. 1–3; 1902, **33**, p. 1–33; and Müller, Otto, Botan. Jahrb., 1903, **34**, p. 9–38, pl. 1–2; p. 256–301, pl. 3–4; 1905, **36**, p. 137–205, pl. 1–3.

[4] See C. Wesenberg-Lund, Plankton Investigations of the Danish Lakes. General Part, 1908, Copenhagen, p. 281, etc.

Nevertheless, there are many differences between the plankton of Victoria Nyanza and Lake Nyassa on the one hand and that of temperate Europe on the other; *e. g.*, it seems that the following dominant species of temperate Europe, viz., Asterionella, *Fragilaria crotonensis* and *Ceratium hirundinella*, are wanting or, with regard to the last species, of small importance in the large African lakes, while on the other side those lakes contain a number of beautiful forms of Surirella and the numerous Desmids. The last feature they have in common with the lakes of West Europe (Great Britain), but the species are different.

The consecutive order of the plankton maxima in Victoria Nyanza is, then, if we may be allowed to judge from our present very limited knowledge, the following:—

February (A. Agassiz): *Melosira Agassizii* dominates, other Diatoms of less importance, Green and Blue-green Algae rather scarce.

April (Cunnington): Green Algae, both Desmids and Protoccoideae dominate; Diatoms of less importance; Blue-green Algae rather scarce.

October (Stuhlmann) and *November* (A. Borgert): Myxophyceae dominant, but both Green Algae (especially *Botryococcus Braunii*) and Diatoms (*Melosira nyassensis* and Surirellae) subdominant. Plankton very rich in species and individuals.

From this fragmentary picture it will be evident how necessary and important it would be to get a regular plankton investigation of Victoria Nyanza throughout a year at least, and with short intervals (a week or a fortnight). It is my hope that this gap in our knowledge of the fresh-water plankton of the earth may soon be realized.

2. The Samples from Mwanza and Shirati.

The phytoplanktons present in the two February samples from Mwanza and Shirati are not so abundant with regard to both species and individuals as the organisms recorded from Victoria Nyanza samples taken later in the year.

The accompanying table will show the species found in the samples and, further, their relative frequency given in the ordinary way, viz., cc denotes "dominant," c "common," + "not common nor rare," r "rare," and rr "very rare" (only a single or few individuals seen). With regard to the frequency the above mentioned circumstance, that the silk gauze used was relatively wide-meshed, must be remembered.

PHYTOPLANKTON FROM VICTORIA NYANZA,

February, 1908.

Species.	Shirati.	Mwanza.
Peridiniales.		
Ceratium hirundinella (O. F. Müll.) Schrank, var. brachyceras (v. Dad.) Ostf.	rr	. . .
Bacillariales.		
Cymatopleura solea (Bréb.) W. Sm., et varr.	+	r
Melosira Agassizii nov. sp.	cc	+
Melosira nyassensis O. Müll. f. Victoriae, O. Müll.	r	r
Stephanodiscus astraea (Ehrenb.) Grun.	rr	rr
Surirella nyassae O. Müll.	rr	. . .
— var. malombae (O. Müll.)	r	r
— var. Engleri (O. Müll.)	r	rr
Surirella bifrons (Ehrenb.) Kütz.	rr	. . .
Surirella Fülleborni O. Müll., var. elliptica O. Müll.	rr	rr
Myxophyceae.		
Anabaena flosaquae (Lyngb.) Brêb.	rr	rr
Chroococcus limneticus Lemm.	rr	rr
Lyngbya Lagerheimii (Möbius) Gomont	r	+
Lyngbya limnetica Lemm.	rr	rr
Microcystis aeruginosa Kütz.	r	+
Microcystis incerta Lemm.	. . .	rr
Chlorophyceae.		
Botryococcus Braunii Kütz.	rr	rr
Closteriopsis longissima Lemm.	r	rr
Coelastrum cambricum Archer, var. Stuhlmanni (Schmidle)	rr	rr
Coelastrum reticulatum (Dang.) Senn.	rr	. . .
Dictyosphaerium pulchellum Wood	. . .	rr
Oocystis lacustris Chod., var.	rr	rr
Pediastrum boryanum (Turp). Menegh., var. granulatum (Kütz.) A. Br.	r	. . .
— var. rugulosum G. S. West	rr	. . .
Pediastrum duplex Meyen	rr	rr
Pediastrum simplex Meyen, var. clathratum (Schröter)	r	rr
Scenedesmus bijugatus (Turp.) Kütz.	. . .	rr
Scenedesmus quadricauda (Turp.) Bréb.	rr	. . .
Staurastrum gracile Ralfs, var. subornatum Schmidle	rr	. . .
Staurastrum leptocladum Nordst., f. africana G. S. West	r	rr
Staurastrum limneticum Schmidle	r	. . .
Staurastrum tohopekaligense Wolle	rr	. . .

The prominent forms are the Diatoms of which again one species is dominant, viz., *Melosira Agassizii*, sp. nov.; this species which is closely related to *M. granulata* occurs also in the plankton in April (recorded by G. S. West, *l. c.*, p. 147, as *M. granulata*) and in November (recorded by me, *l. c.*, p. 338, as *M. aff. granulata*), but is both in April and November less abundant than *M. nyassensis*, while in February *M. Agassizii* is more abundant than *M. nyassensis.* *Melosira nyassensis* and the forms of Surirellae are less abundant in February than later in the year, and *Nitzschia nyassensis* is very rare.

In the samples from Shirati I have found a few species of the peculiar form of *Ceratium hirundinella* which inhabits Victoria Nyanza. It has also been recorded from April, October, and November, but at all times very sparsely. It would be quite strange if this organism, which in temperate lakes plays so dominant a part in the composition of the plankton and which always has a great maximum of development, should not behave in the same manner in Victoria Nyanza, but hitherto we have no indications as to this point.

If we pass over to the *Green Algae* we find that several species have been found in the February samples, but that all are very rare, and it must be added that some of the individuals met with were dead, especially among the species of Staurastrum. Also the *Blue-green Algae* are very unimportant in the samples, only *Microcystis aeruginosa* and *Lyngbya Lagerheimii* reaching to +. Of these Microcystis occurs in colonies of a peculiar kind, the mucus-envelope being unusually firm (a resting stage?); *Lyngbya Lagerheimii* is a tycholimnetic species carried out in the water from the shore and bottom by the waves.

The table shows further that there is very little difference between the two samples.

3. Remarks on Some of the Observed Species.

A. Peridiniales.

Ceratium hirundinella (O. F. Müll.) Schrank, var. *brachyceras* (v. Dad.) Ostf., *l. c.*, p. 345; *C. brachyceros* E. v. Daday, Plankton-Tiere aus dem Victoria Nyanza, in Zool. Jahrb. Abt. f. System., 1907, **45**, p. 251, fig. A; *C. hirundinella*, G. S. West, *l. c.*, p. 189, pl. 9, fig. 4.

The form of Ceratium which occurs in Victoria Nyanza is, as above mentioned, a very aberrant one. E. v. Daday has described it as a new species closely related to *C. hirundinella* and has given a rather rough drawing of it. At about the same time G. S. West recorded it as *C. hirundinella* and figured it very well. His description contains the main points in which it differs from typical *C. hirundinella.* He says that "the few specimens observed differed very much from any others which have come under my notice." The more important differences from *C. hirundinella* are: (1) the short and clumsy horns, (2) the very much reduced second antapical horn and its place close to the first one, much nearer than in the typical form, (3) the strong reticulation of the plates. In all these respects the Victoria Nyanza Ceratium comes near to *C. cornutum* (Ehbg.) Clap. & Lachm. In my former paper on Victoria Nyanza plankton, following West, as I had not seen any entire and undamaged specimen, I have considered it as merely a form of *C. hirundinella*, but now, when I have examined better material, I must admit that its diversity from the type is so great that it deserves at least varietal rank.[1]

With regard to the arrangements of the plates which have not been given by either of the two earlier observers, my drawings (pl. 2, figs. 15 and 16) show that the arrangement is quite typical (see C. A. Kofoid, Zool. Anzeiger, 1907, **32**). I have also given a drawing of a specimen with its plasma protruding as a spherical body outside longitudinal furrow (pl. 2, fig. 17). All the few specimens observed were found in this condition, which remind us of the observations on copulation in *Ceratium hirundinella* first described by E. Zederbauer (Ber. Deutschen Botan. Ges., 1904, **22**, p. 1–8, pl. 1). The specimens observed varied between 150 μ and 165 μ in length.

B. Bacillariales.

The plankton Diatoms present in the samples are *Nitzschia nyassensis* O. Müll., *Stephanodiscus astraea* (Ehbg.) Grun., *Cymatopleura solea* (Bréb.) W. Sm., with several varieties, some forms of Surirella, and two species of Melosira.

Cymatopleura solea occurs in the following varieties which apparently are connected through intermediate forms: 1. *typica*, 2. *subconstricta* O. Müll., 3. *clavata* O. Müll., 4. *laticeps* O. Müll., and 5. *nyanzae* G. S. Westpro sp.

Surirella. The many handsome forms of this genus have attracted the attention of all former observers. In his excellent paper on the Nyassa Diatoms Professor Otto Müller treats them in great detail and describes a number of new species from Lake Nyassa and adjacent lakes. G. S. West also records many species from Lake Nyassa, from Victoria Nyanza, and from Lake Tanganyika; he points out (*l. c.*, p. 165) with regard to some of the species that there occur intermediate stages between them. When I studied the Victoria Nyanza samples collected by Professor A. Borgert, I could not identify the specimens observed with Müller's species as they seemed to form continuous series from one species to another. I therefore asked Professor Müller to examine my slides, and this he did with his usual readiness, and placed at my disposal the results of his examination, permitting me to publish them in my paper. From his notes therein I quote the following sentences, which show that my suggestion on the absence of distinct limits between the species was quite correct: —

---

[1] Prof. Charles A. Koford has kindly drawn my attention to a form described by A. Hempel (Bull. Illinois State Lab. Nat. Hist., 1896, **4**, p. 314, pl. 25, fig. 11 and 12, pl. 26, fig. 13) as *Ceratium brevicorne*; it resembles our form in many respects but differs according to the description and the figures in others, *e. g.*, the position and shape of the short second antapical horn; and I hesitate to consider the two forms identical.

"Die im Plankton des Victoria Nyanza enthaltenen Surirellen sind . . . mannigfacher gestaltet und in grösserer Anzahl vorhanden, als diejenīgen des Nyassa- und Malombasees. In den letzgenannten Seen sind die drei Arten *S. Nyassæ*, *S. Malombæ* und *S. Engleri* ziemlich scarf begrenzt; im Victoria Nyanza dagegen finden sich vorwiegend Übergangsformen, d. h. die typischen Arten kommen nur selten und meistens in veränderten Grössen vor, an ihrer Stelle aber sind gleitende Übergänge zwischen den drei Arten vorhanden" (*l. c.* p. 340–341).

He then gives a number of measurements of the observed specimens, studying the limits of their variation, and concludes: —"es dürfte daher über den Zusammenhang von *S. Nyassæ* und *S. Malombæ* kaum ein Zweifel bestehen" (*l. c.*, p. 341); and further: — "Alle diese Abweichungen bilden eine Reihe, deren Endglider *S. Nyassæ* und *S. Malombæ* sind. Ebenso deutlich ist der Zusammenhang von *S. Nyassæ* und *S. Éngleri*, var. *constricta*" (*l. c.*, p. 342).

In his own paper on Nyassa Diatoms part 1 (1903), O. Müller has illustrated the new species of Surirella with beautiful drawings; we find there the typical forms of his species; but the intermediate stages — such as they occur in Victoria Nyanza — have not been illustrated in my former paper. Therefore I take the opportunity to fill out this lacuna in reproducing a series of microphotographs taken by Mr. A. Hesselbo under my direction. When one wishes to demonstrate a series of transition stages, it is always better to use the camera than to rely upon drawings which can be spoken of as influenced by the author's own opinion.

All the microphotographs have been taken at the same magnification (× 300) and are fully comparable. Fig. 1 represents a typical *S. nyassae* O. Müll., Figs. 9–10, typical *S. malombae* O. Müll., and Fig. 13, typical *S. Engleri* O. Müll, var. *constricta* O. Müll. I trust that the figures from 1 to 10, Plate 1, show at once how continuous the transition from *S. nyassae* to *S. malombae* is; further that in Fig. 2, 3, and 4 we find transitions through Fig. 11 and 12 to Fig. 13, that is from *S. nyassae* to *S.*

Engleri, var. *constricta*, of which Fig. 14 is a gigantic form. The transitions manifest themselves in all distinctive characters, viz., the shape of the valve, its size, and the number of "costae" in a given area (*e. g.*, 10 μ) ; this last character separates *S. Engleri* from the two others.

If we admit that there are no distinct limits between the forms, I think it is better to unite them as one species, retaining the most diverging forms as varieties, and I propose to name them *S. nyassae* O. Müll. with the var. *Engleri* (O. Müll.) and var. *malombae* (O. Müll.).

Another question is, if we should subordinate them all under the older species *S. bifrons* (Ehbg.) Ktz. and *S. constricta* Ehbg. To answer this question it would be necessary to take up for study a large number of species of which I have no authentic material, but must rely upon the drawings in A. Schmidt's Atlas, in W. Smith's British Diatomaceae, and in H. Van Heurck's Atlas, as well as earlier publications by Ehrenberg, Kützing, etc. The chance for error is, I think, too great, and I will not enter upon the matter, but will confine myself to the reduction already made.

Besides, the large Surirellas of the plankton of the East African lakes are so peculiar that they deserve to be distinguished. perhaps, also, by maintaining the names given to them.

MELOSIRA. With regard to the Melosira forms of the Central African lakes, much the same may be said, as in the case of Surirella. Our knowledge of them is also due to Professor Otto Müller, and in his paper on Nyassa Diatoms (part II, 1904) he has given an exhaustive study of the Melosira forms of this region. Further, he has examined the Melosirae occurring in Victoria Nyanza slides sent him by me and has given his notes on these forms in my paper (*l. c.*, p. 338–339). The most common form in these slides, which have been made from Professor Borgert's material, is a slightly divergent form of *M. nyassensis* O. Müll., named by Müller, var. *Victoriae* O. Müller. This form occurs also in the samples taken by Dr. Agassiz, but is not the dominant one; it seems to attain its maximum later in the year. The dominant Melosira of the February samples — and it is the most common species of the whole phytoplankton — is the same as Müller mentions as a new species in the Borgert samples, where it was not so common. As it stands near *M. granulata* (Ehrbg.) Ralfs, I have recorded it in my paper as "*M. aff. granulatam.*" Now when I have had excellent and rich material at my disposal, I think myself justified in describing it as a new species, which I name in honor of Dr. Alexander Agassiz.

MELOSIRA AGASSIZII, sp. nov. (pl. **2**, fig. 18–22). *Ex affinitate M. granulatae. Theca cylindrica, robusta; disci circulares, arcte connati, margine denticulato; discus valvae terminalis dentibus longis inaequalibus marginalibus praeditus; pseudo-sulcus (sensu de O. Müller) distinctus; pars cylindrica valvae ut visa aspectu cingulato rectangulata cum lateribus duobus incurvatis, granulis (poris) rotundis in seriebus curvatis (in valva terminali rectis),* 10–12 *in* 10 μ *praedita; sulcus distinctus in lumine cellulae prominens. Diametrum cellulae* (12–)24–42 μ, *altitudo partis cylindricae valvae* 9–14 μ.

This species is larger and coarser than *M. nyassensis*, and is, when seen in side view, easily recognized by the more or less inwardly curved sides of the cylindrical parts of valves, the inwardly prominent sulcus, the round pores, and the long marginal teeth of the terminal valve. The description given by O. Müller in my paper is as follows: "Die zweite Art gehört offenbar zum Formenkreise von *Melosira granulata*, denn sie besitzt die, diesen Art eigenthümlichen, langen Dornen an den Endhälften des Fadens. Sie stimmt indessen nicht mit *M. granulata* selbst überein. Die Zellwand ist stärker als bei *M. granulata*, die inneren Mantellinien sind nicht gerade, sondern nach dem Zelllumen zu konkav. Die Porenreihen verlaufen in stark gekrümmten Linien, 10–12 auf 10 μ; in den Endhälften des Pervalvarachse parallel, 14–15 auf 10 μ. Poren kreisrund. Sulcus eine Hohlkehle. Der Durchmesser schwankt von 12–30 μ die Höhen der Zellhälften messen 9–15, 5 μ."

It will be seen that this description agrees very well with my drawings and my diagnosis. Only my specimens are somewhat larger; I have found the diameter varying from 24 μ to 42 μ, while Müller in his material found 12 μ to 30 μ. Now my specimens were collected at a time when the species has probably its maximum, and perhaps there has been a formation of auxospores before this maximum. This would explain the differences in diameter; but it is only a supposition, as I have not succeeded in finding any trace of such auxospores.

There is another matter with regard to this species which may have some interest. Undoubtedly it was in full and active development in February when taken; this is evident from the many cell-divisions observed. Although the preservation of the cell-contents has not been entirely satisfactory, some points of interest have been made out, as I hope the accompanying drawings will show. Plate **2**, fig. 19 shows two cells of a normal filament, not in cell-division; through the preservation the plasma has withdrawn from the inner side of the cell-wall; but the nucleus is distinct and the aggregated chromatophores are also visible; the girdle part of the cell-wall is very narrow. When the cells begin to divide, the two valves diverge, and a large girdle part becomes formed, as shown in Plate **2**, fig. 20. This girdle part has no structure at all; it is only a very thin, hyaline, silicious tube or cylinder, as can be clearly seen in ignified specimens mounted in styrax balsam, where the transparent girdle is contrasted with the porulate valves. As Plate **2**, fig. 21 shows, the plasmatic contents are much altered at this stage; the plasma lies close to the girdle wall; and must be adherent to the inner side of it, as it has not withdrawn in the preservation. The nucleus is large and of an amoeboid shape, and nearly all the chromatophores are aggregated in the parts of the plasma nearest to the disc. A later stage has been given in Plate **2**, fig. 22. The cell-division is now accomplished, and the cell-wall is nearly everywhere as thick as usual, the discs only being somewhat thinner, but the plasma has not reached its final condition. It lies close to the newly formed disc-walls, and only few of the chromatophores have changed their place, the main part remaining aggregated in the part of the plasma most remote from the new cell-wall, and here we find also the nuclei. Some time later the initial stage (Plate **2**, fig. 19) is again reached. I think that the manner of cell-division here described — and this is, I believe, the normal manner in this group of Melosirae — has the effect that the diminution of size, so characteristic for the Diatoms, is reduced to a minimum in spite of the very thick cell-wall of these species. It would be an interesting matter to follow the process more closely on fresh material and on material fixed for cytological purposes.

C. Myxophyceae and Chlorophyceae.

With regard to the Blue-green and the Green Algae very little is to be said, as they play so small a part in the February samples. It is sufficient to refer to the papers by W. Schmidle (1898), G. S. West (1907), and myself (1908), as they are based upon much better material of these Algae. I have only two small points to add, both due to examination of a sample of phytoplankton from Lago di Muzzano in Tessin (Switzerland) collected by me on July 20, 1908.[1] The phytoplankton of Lago di Muzzano was very rich in Green Algae. Among the many species observed was a form of *Pediastrum boryanum* which agreed exactly with var. *rugulosum* described by West (*l. c.*, p. 136, pl. 5, figs. 8–9) from Victoria Nyanza; this form is then not endemic for Victoria Nyanza, but is probably a warm-water form. An analogous phenomenon is that *Coelastrum Stuhlmanni*, described by W. Schmidle (Botan. Zentralblatt, 1900, **81**; Engler, Botan. Jahrb., 1902, **32**, pl. 3, fig. 8) from Victoria Nyanza, occurred also in Lago di Muzzano, and through all intermediate stages was connected with *C. cambricum* Archer, of which it is to be considered as merely a variety. The main character in *C. Stuhlmanni* is the prominent ribs radiating from the external tips of one cell to the tips of another; in Lago di Muzzano some coenobia without these radiating ribs were found, others with radiating ribs on some of the cells, and others again which were true *C. Stuhlmanni.* Already in my paper (*l. c.*, p. 337) I had suggested that *C. Stuhlmanni* was nearly related to *C. cambricum*, var. *elegans* C. Schroeter, and this has now proved to be the case; but perhaps we may retain the form as a variety, viz., *C. cambricum*, var. *Stuhlmanni* (Schmidle) Ostf. In this way one more of the endemic forms for Victoria Nyanza has disappeared.

---

[1] Water temperature 20° C.

PLATE I.

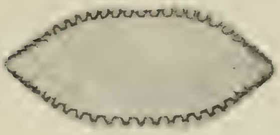
Figs. 1–10 show the transition from *Surirella nyassae* O. Müll. into *S. malombae* O. Müll.

Figs. 11 and 12 show the transition from *Surirella nyassae* into *S. Engleri* O. Müll. var. *constricta* O. Müll.

Fig. 13. *S. Engleri,* var. *constricta.*

Fig. 14. *S. Engleri,* var. *constricta,* gigantic form.

All the figures are from microphotographs taken by Mr. A. Hesselbo ; × 300.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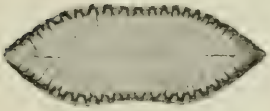
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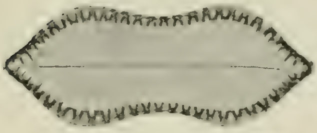
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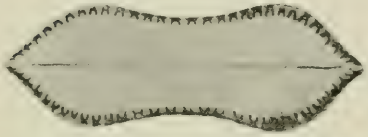
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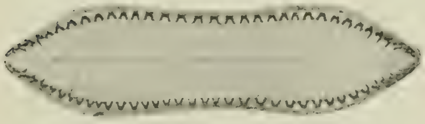
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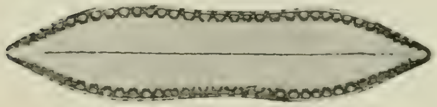
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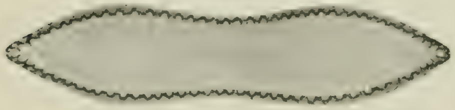
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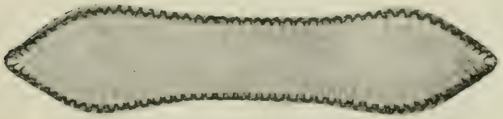
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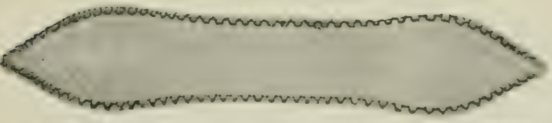
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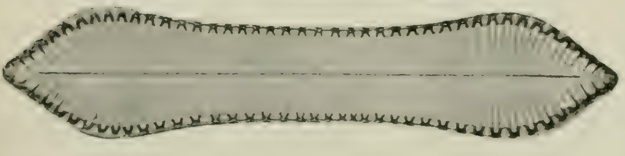
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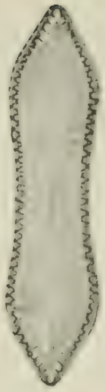
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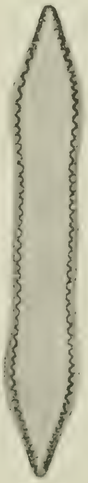
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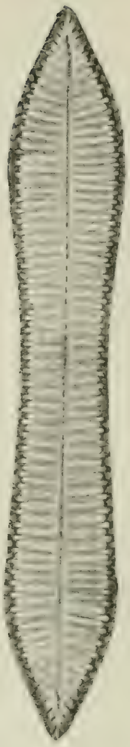
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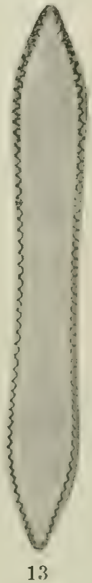
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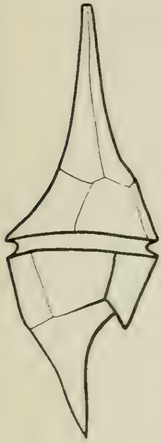
A. Hesselbo phot.

PLATE 2.

FIGS. 15–17. *Ceratium hirundinella* (O. Müll.) Schrank, var. *brachyceras* (v. Dad.) Ostf. Fig. 15, seen in dorsal view and a little from antapex; Fig. 16, seen from the left side and a little from antapex; Fig. 17, cell with contents in ventral view.

FIGS. 18–22. *Melosira Agassizii*, sp. nov. Fig. 18, part of a filament with terminal cell, showing wall structure; Fig. 20, diagrammatic drawing of a filament with large hyaline girdle parts; Fig. 19, two cells with contents; Fig. 21, three cells in divisions; Fig. 22, two cells with recently completed division.

Figs. 15–17. $\frac{\text{oc. } 6}{\text{ob. } 4.0}$, Fig. 18. $\frac{\text{oc. } 8}{\text{ob. } 2.5}$, Fig. 20. $\frac{\text{oc. } 8}{\text{ob. } 8.0}$, Figs. 9, 21, 22, $\frac{\text{oc. } 8}{\text{ob. } 4.0}$; all Zeiss's apochromatic objectives and compensation oculars.



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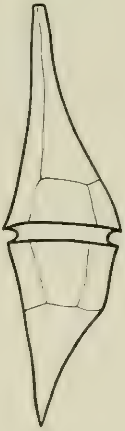

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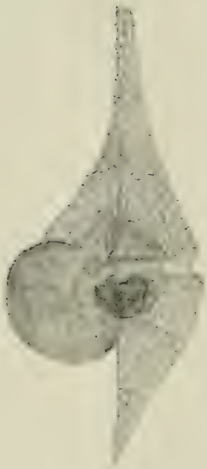

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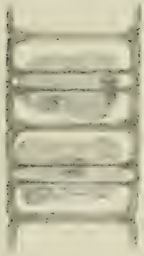

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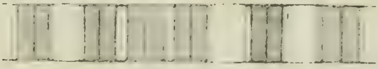

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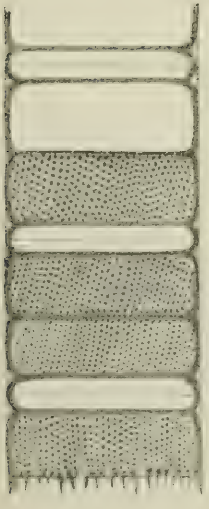

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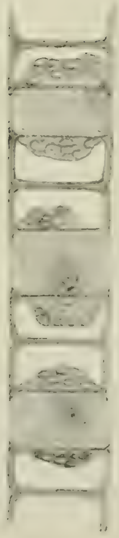

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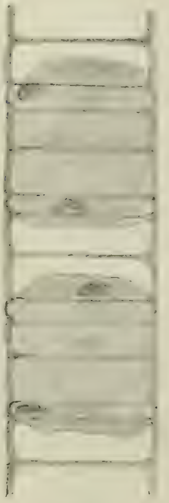

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C. H. O. del.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LII. No. 11.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XIX.

PYCNOGONIDA.

By Leon J. Cole.

With Three Plates.

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No. 11. — *Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of* ALEXANDER AGASSIZ, *by the U. S. Fish Commission Steamer "Albatross," from October*, 1904, *to March*, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., *Commanding.*

XIX.

Pycnogonida. BY LEON J. COLE.

During the cruise of the "Albatross" in the Eastern Pacific in 1904, pycnogonids were taken at four stations. In all there were only six specimens obtained, three of which, however, belong to a species previously undescribed. When it is recalled that the "Albatross" made explorations in this same region in 1891, it is not surprising that the other two species represented by the remaining three specimens should have been taken in the collections made at that time. A few additional notes on these two species, together with a description of the new form, are presented herewith.

Ascorhynchus agassizii SCHIMKÉWITSCH.

Pl. 1, fig. 1: Pl. 3, figs. 5, 6.

Bull. Mus. Comp. Zoöl., 1893, **25**, p. 36, pl. 1, figs. 4–6; pl. 2, figs. 12, 13, 16, 17.

One female; Station 4630; Nov. 3, 1904; lat. 6° 52′ N.; long. 81° 42.5′ W. (Gulf of Panama); 556 fathoms; bottom, green sand, large globules.

One female; Station 4631; Nov. 3, 1904; lat. 6° 26′ N.; long. 81° 49′ W. (Gulf of Panama); 774 fathoms: bottom, green sand.

These two specimens were taken at stations not far apart, and but a comparatively short distance from the locality where the species was first found, in 1891. They are of about the same size, and agree very closely with the description given by Schimkéwitsch. His description is, however, apparently based entirely, or nearly so, upon the male, and his figures are from a specimen of that sex. The females taken in 1904 are noticeably smaller than his measurements;[1] the dorsal

---

[1] The specimen from Station 4631, which is slightly the larger, measures 32 mm. from tip of proboscis to tip of caudal segment, when straightened out, while the extent along the third legs is about 135 mm.

tubercles of the trunk-segments and of the lateral processes are very much less pronounced, and the animals are rather less spinous throughout. Thus the proximal joints of the palp are practically smooth, and the stiff spines on the fifth joint described and figured by Schimkéwitsch (1893, pl. 2, fig. 12) appear to be lacking entirely. The ovigers are considerably shorter in proportion, while the bristles forming a tuft at the end of joint 6 are only about half as long as joint 7 instead of equalling that joint as they do in the male. Through the kindness of the authorities of the United States National Museum I have had opportunity to examine the specimens described by Schimkéwitsch, and I find that this latter difference holds in the case of the female of that lot. Otherwise the ovigers of the two sexes are nearly alike.

The eye tubercle is lower and less pointed in the specimens collected in 1904.

There are two or three discrepancies in Schimkéwitsch's description, as when he states in speaking of the joints of the leg (*loc. cit.*, p. 38), "le quatrième est une fois et demie plus long que le second." His own figure (pl. 1, fig. 4) as well as both lots of specimens I have examined show it to be fully twice as long. Again, on the same page, he arranges the third joint as intermediate in length between the fifth and sixth, which is obviously a mistake. He gives the arrangement of the joints of the leg, going from longer to shorter, as follows: 4, 5, 3, 6, 2, 7, 8, 1; the series should read, 4, 5, 6, 2, 8, 7, 1, 3. Joints 7, 1 and 3 may be nearly of the same length, but that joint 8 is longer than joint 7 is shown in Schimkéwitsch's own figure (1893, pl. 2, fig. 16).

As will be observed from what has been said above, the two specimens collected by the Eastern Tropical Pacific Expedition, differ from those described by Schimkéwitsch principally in the smaller size, the decidedly less developed dorsal protuberances, and the less pronounced spinosity of the palps. I cannot but believe, nevertheless, that they merely represent probably younger individuals of the same species, though they possess the adult characters of having the chelifori not distinctly chelate (the condition is shown in pl. 3, fig. 6), which is usually a characteristic of the young in this genus, and the genital openings[1] are plainly distinguishable in the usual position on all four pairs of legs. It is to be noted, however, that these specimens came from much shoaler water than those examined by Schimkéwitsch (556 fms. and 774 fms. as compared with 1270 fms. and 1573 fms.), and it is possible that they may represent a shoaler-water type or subspecies. I do not care, however, to name it as such on the insufficient material at hand.

Ascorhynchus agassizii is certainly very close to *A. glaber* Hoek in general appearance and proportions, and if they came from less widely separated localities I do not think I should hesitate, from the descriptions, in considering them the same. Since they come from such widely separated localities, however, it seems better to let the matter stand as it is, at least until specimens of the two can be compared directly. Furthermore, although Hoek (1881, p. 147) is of the opinion that *A.* (=*Scaeorhynchus*) *armatus* (Wilson) [1] is distinct, I think there can be no doubt that it approaches very closely to the species discussed above. We know far too little about the range of variation during growth and in different individuals to base very positive conclusions upon a few specimens.

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[1] It is usual in this genus for the genital openings to occur on all four pairs of the legs in the female, and only on the third and fourth pairs in the male. Upon careful examination, however, of two of the males taken in 1891 and reported on by Schimkéwitsch (1893), I discovered that in one of these there is *an additional genital opening* situated on the second leg of the right side. No corresponding opening could be detected on the left side.

Colossendeis gigas Hoek.

Pl. 1, fig. 2; pls. 3, 7.

Colossendeis gigas Hoek, Challenger Reports, **3**, pt. 10, Pycnogonida, 1881, p. 61–64, pl. 8, figs. 1, 2; pl. 10, figs. 1–5.

Colossendeis gigas Schimkéwitsch, Bull. Mus. Comp. Zoöl., **25**, 1893, p. 29, 30.

One small immature specimen; Station 4672; Nov. 21, 1904; lat. 13° 11.6′ S.; long. 78° 18.3′ W. (off Callao, Peru); depth 2845 fathoms; bottom, fine green clay, infusorian earth full of Diatoms.

This specimen, though small, agrees very closely with the description of *C. gigas* given by Hoek.

Schimkéwitsch considered *C. gigas* Hoek to be specifically identical with *C. colossea* Wilson (1881, p. 244). That being the case he should have employed the latter name for the species instead of the former, since Wilson's description has priority of publication. Hoek himself (1881, p. 147) noted the resemblance of the two and suggested that they might be identical. Loman (1908, p. 21) discusses the question and is of the opinion that they may be local varieties of a widely distributed deep-sea species. I have compared *C. colossea* from the North Atlantic with the two specimens taken upon the "Albatross" Expedition of 1891 and reported upon by Schimkéwitsch (1893), as well as with the small specimen taken in 1904. The most constant difference appears to be in the proportion of the legs, which are about five times the length of the body (including proboscis and caudal segment) in the Atlantic specimens, and only four times the length of the body in those from the Pacific. Furthermore, the first tibial joint is about equal in length to the femur in the former, whereas it is shorter (by about the length of the third coxal joint) in the latter. There may be other minor differences, but it is difficult to determine their constancy from a small series of specimens. In the characters mentioned the Gulf of Panama specimens agree more closely with the description of *C. gigas* Hoek than do the North Atlantic specimens. For this reason I have retained the name of that species and referred them to it, thus following the course of other recent authors in leaving it distinct from *C. colossea*, though I have little doubt that future collections will reveal intergrading forms, making it necessary to reduce *C. gigas* to subspecific rank.

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[1] Wilson (1881, p. 248).

Colossendeis cucurbita, sp. nov.

Pl. 2, figs. 3, 4; pl.3, fig. 8-12.

Three specimens (two large and one small) from Station 4647; Nov. 9, 1904; lat. 4° 33′ S.; long. 87° 42′ 30″ W. (approximately midway between Aguja Point, Peru, and the Galapagos Islands); depth 2005 fathoms; bottom light gray and brown Globigerina ooze.

Type. — Collection U. S. National Museum.

Specific diagnosis. — Closely related to *Colossendeis gigas*, but proboscis with an upward curve, and fourth joint of palp longer than second.

Description. — Trunk moderate for the genus, possibly a little more slender than in *C. gigas* and *C. colossea;* no trace of external segmentation. Lateral processes short, considerably shorter than width of trunk; well separated, the spaces between them only a little less wide than the processes; broader distally, and separated from the trunk by a distinct furrow. Across the dorsal surface of the trunk, starting even with the anterior edge of the first lateral processes, is a distinct, broadly V-shaped groove, with its convexity directed posteriorly. This groove marks off the anterior part of the first trunk segment from the remainder of the trunk, which is nearly evenly cylindrical, except that its diameter is greater, both laterally and dorso-ventrally, opposite the second and third lateral processes. This anterior part, or "head," is, however, even broader than the trunk behind it, but is narrowed anteriorly so that its sides are convex, thus giving it a rounded outline as viewed from above. Ventro-anteriorly it is produced slightly for the attachment of the palps and ovigers. Viewed laterally this "head" portion is seen to be bent downward slightly, so that the axis of the proboscis, which arises directly from its anterior end, is depressed at a slight angle from the horizontal plane of the body.

Caudel segment directed straight backward in the plane of the body. There is a distinct articulation at its point of juncture with the trunk. Length equal to that of the first two coxal joints of the third legs; as these joints are somewhat shorter in the fourth legs, its tip reaches a little beyond the distal end of the second coxal joint of that pair. Shape slender, slightly clavate, the distal end turned somewhat upward; greatest diameter considerably less than that of the palps.

Eye tubercle a low, rounded, transverse ridge situated just forward of the middle of the "head." Ocelli two, small, round, widely separated; they are marked by a brown pigment which makes them distinctly visible.[1]

Proboscis one and one-half times as long as the trunk and caudal segment combined; as stated above, it arises directly from the anterior face of the first trunk segment, but is directed slightly downward from the horizontal axis of the trunk. Proximally it is narrow, the breadth being about equal to that of the trunk between the third lateral processes; this diameter remains nearly constant for about a third of the length, when it expands to nearly double; in its distal third the proboscis again narrows, but remains considerably thicker than the proximal portion, and at the tip it again expands to a diameter only a little less than that of the middle third. The distal portion has a distinct upward curve. The proboscis as a whole may then be divided into three parts: the proximal third is narrow and cylindrical; the middle third forms an expanded bulb of greater diameter than any part of the trunk; while the remaining third is narrower again, curves slightly but distinctly upward, and is expanded at the tip, which is composed of three blunt lobes and is terminated by the triangular mouth. The general shape of the proboscis resembles somewhat certain elongated gourds or squashes, and this has suggested the specific name.

---

[1] They are much less conspicuous in the small specimen.

Palps but little longer than the proboscis; when extended the distal end of the sixth joint comes even with the end of the proboscis. First and second joints short and knob-like; the first really somewhat triangular as seen from the side, being broader distally; the second short and disc-like. Third joint slender, very slightly less than one-third the length of the proboscis; expanded considerably at the distal end. Fourth joint nearly as broad as this expanded end of the third, and only about as long as broad. Fifth joint somewhat over half again as long as third; of about the same diameter as that joint proximally, but gradually expanding toward the distal end. Joint six about twice as long as four; joint seven one and one-half times six, or in other words, equal to the lengths of joints four and six combined, but of distinctly smaller diameter; eighth joint very small; ninth a little longer; tenth very slender and equal in length to eight and nine taken together. The proximal parts of the palp are smooth, but the distal part of joint six and joints seven to ten are provided with numerous short, stiff hairs.

Oviger somewhat longer than the entire body (tip of proboscis to tip of caudal segment). First three joints short, rounded, and arising directly behind the origin of the palps from a process of the trunk which is almost as large as one of the coxal joints of the appendage. The fourth joint is long and slender, but gradually increases in diameter toward its distal end. The length of these four joints, together with that of the process from which the appendage arises, is almost exactly equal to the length of the proboscis. The fifth joint is short, its length being equal to that of joints $1 + 2 + 3$. The sixth joint resembles the fourth in shape, but is slightly longer, being equal in length to joints $2 + 3 + 4$. The remaining joints are short and coil closely around in a little spiral, the terminal joint thus overlapping joint seven on its mesial side, as shown in Fig. 9. Joint seven is about three-fourths the length of joint five; the succeeding joints decrease gradually in length and diameter to the small terminal claw which constitutes the eleventh joint of the appendage. The oviger is armed only by a series of three or four rows of rather simply "denticulate" spines on the outer curvature of joints seven to ten, and a few minute stiff spines on the outer side of these same joints and extending along the opposite side of joint six.

Legs about three times the length of the entire body from tip of proboscis to tip of caudal segment; they vary somewhat, the second pair being the longest, the third pair a little shorter, followed by the fourth pair, the first pair being the shortest of all. The three coxal joints short, each being about as long as broad, and somewhat longer than the lateral process; the three together equal half the length of the trunk proper, from the base of the proboscis to the base of the caudal segment. Femur slender, slightly curved, somewhat longer (in the second legs) than the length of the body; first tibial joint equals the femur in length, more slender, but not tapering; second tibial joint a trifle over two-thirds the length of the first, and tapering evenly toward its distal end. The tarsal joints are short, the first being about equal to the length of the coxal region, and the second slightly more than half the length of the first; both are practically straight, and are armed only with a slight projection ventrally at their distal ends. The claw is small, scarcely over a fourth the length of the second tarsal joint, and stout for its length. Auxiliary claws wanting.

On the ventral side of the second coxal joint, is a low transverse prominence. This is somewhat more pronounced on the third and fourth legs, where the small genital apertures are situated, not at the very top, but upon its proximal face. The genital apertures were plainly distinguished in the two larger specimens, which dissection showed to be females, but could not be made out in the small individual, the sex of which was not determined.

The body and appendages, except as noted in the above description, are entirely smooth. The two larger specimens are a light straw-color (in alcohol); the smaller one is lighter. Under the microscope the integument has a granular appearance, due to its being marked everywhere by minute irregular whitish dots.

Measurements in Millimeters.

Specimen	Sex	Proboscis	Trunk	Caudal segment	Total length	Palp	Oviger	First leg	Second leg	Third leg	Fourth leg
a (type)	♀	27	15	5	47	34	62	131	145	140	135
b	♀	25	13	4	42	32	58	128	138	134	130
c	?	16	10	3	28	23	38	87	97	91	88

Attached to the legs of one of the larger specimens (specimen *b*) were a half-dozen curious capsules, which I judge are similar to those found by Hoek (1881, p. 65 and 143) on three specimens (two females and a male) of *Colossendeis leptorhynchus.* These bodies are 2 to 2.5 mm. in diameter, and more or less hemispherical in shape (pl. **3**, fig. 12). There arises excentrically from the flatter side a short stalk by which they are fastened to the legs of the pycnogonid. The interior contains a quantity of whitish flocculent material, among which are small bodies 0.07–0.1 mm. in diameter, which appear to be eggs. Sections of this poorly preserved material gave an appearance similar to that described by Hoek. Whereas Hoek describes his specimens as being "sprinkled over" with these bodies, they have in the present instance a peculiarly regular arrangement, a pair being attached close together near the proximal end of the femur of three different legs, viz., the second and third legs of the right side and the third left leg (pl. **3**, fig. 11). This arrangement would appear to suggest either that it is difficult for the animal to reach this particular part of the leg in order to clean it, in case the capsules are not to be considered as pertaining to the species, or else that this is the regular position for the attachment of the egg capsules of the pycnogonid itself. It is a singular fact that the external egg masses appear to be unknown in this genus, and Hoek discusses the possibility that these capsules may be the form they take in these animals. He considers this view as improbable, however, and calls attention to the fact that they occur on both sexes, whereas it is the almost universal rule among the Pycnogonida (a single known exceptional instance) that the eggs are carried by the male upon his ovigers.

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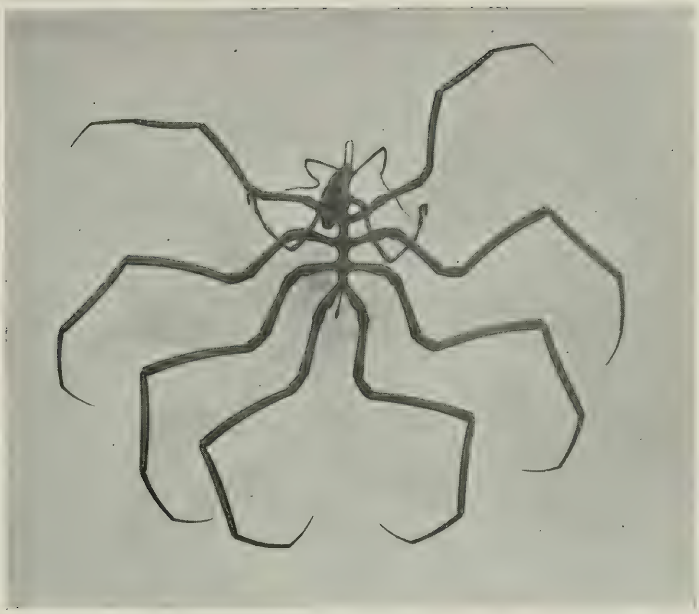
PLATE 1.

(Photographs by A. Hyatt Verrill.)

Fig. 1. *Ascorhynchus agassizii* Schimkéwitsch, female, from above. Albatross station 4630.

Fig. 2. *Colossendeis gigas* Hoek, from above. Albatross station 4672. (The wrinkle across the proboscis is artificial.)



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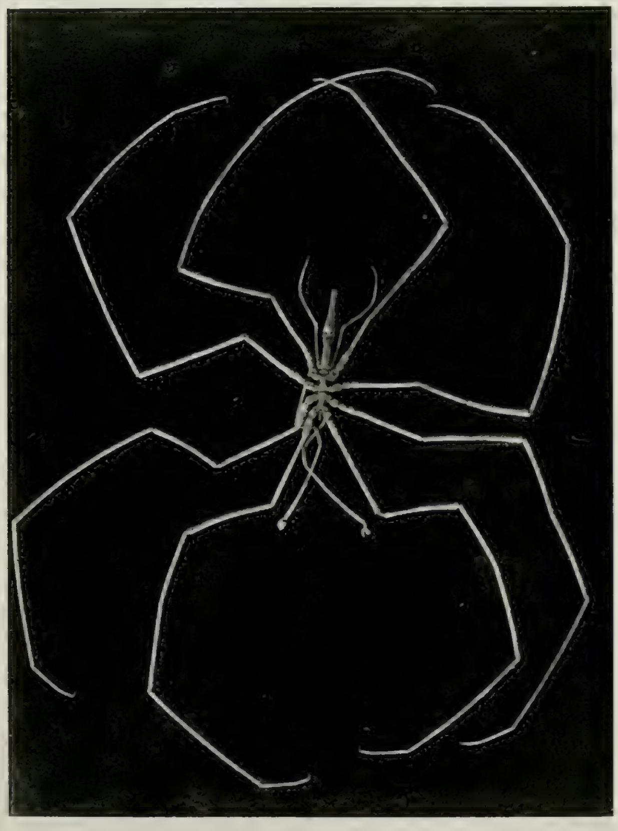

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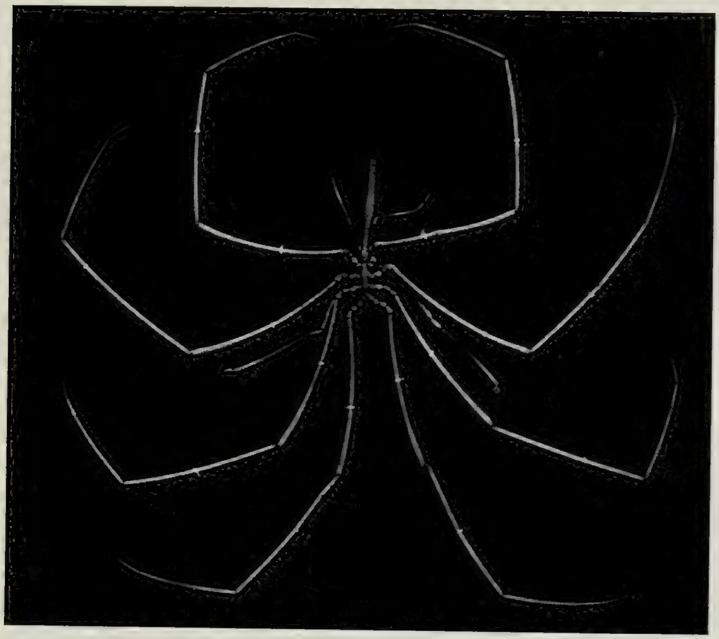
PLATE 2.

(Photographs by A. Hyatt Verrill.)

Fig. 3. *Colossendeis cucurbita*, sp. nov., female, from above. Albatross station 4647. Type. (The white lines across the legs are threads used to hold the specimen down while it was being photographed.)

Fig. 4. The same specimen seen from the side and a little above.



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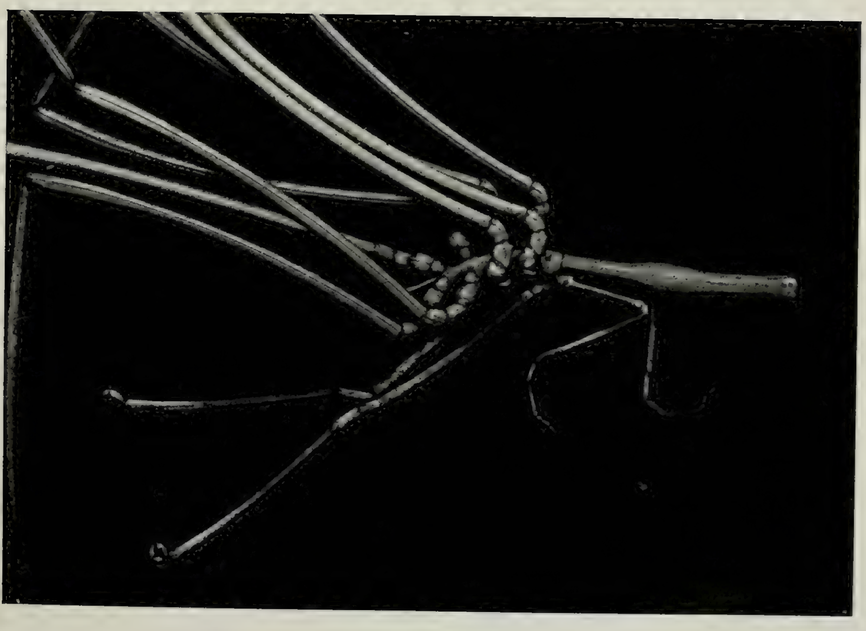

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PLATE 3.

Fig. 5. *Ascorhynchus agassizii* Schimkéwitsch. Same specimen as in pl. **1**, fig. 1. Side view, walking legs not shown. × 3.

Fig. 6. Chelifori of the same specimen seen from above. × 12.

Fig. 7. *Colossendeis gigas* Hoek. Side view of anterior part of first trunk segment, proboscis, and right palp. From a specimen taken at Albatross station 3381, in 1891 (*cf.* Schimkéwitsch, 1893, p. 29). × 3.

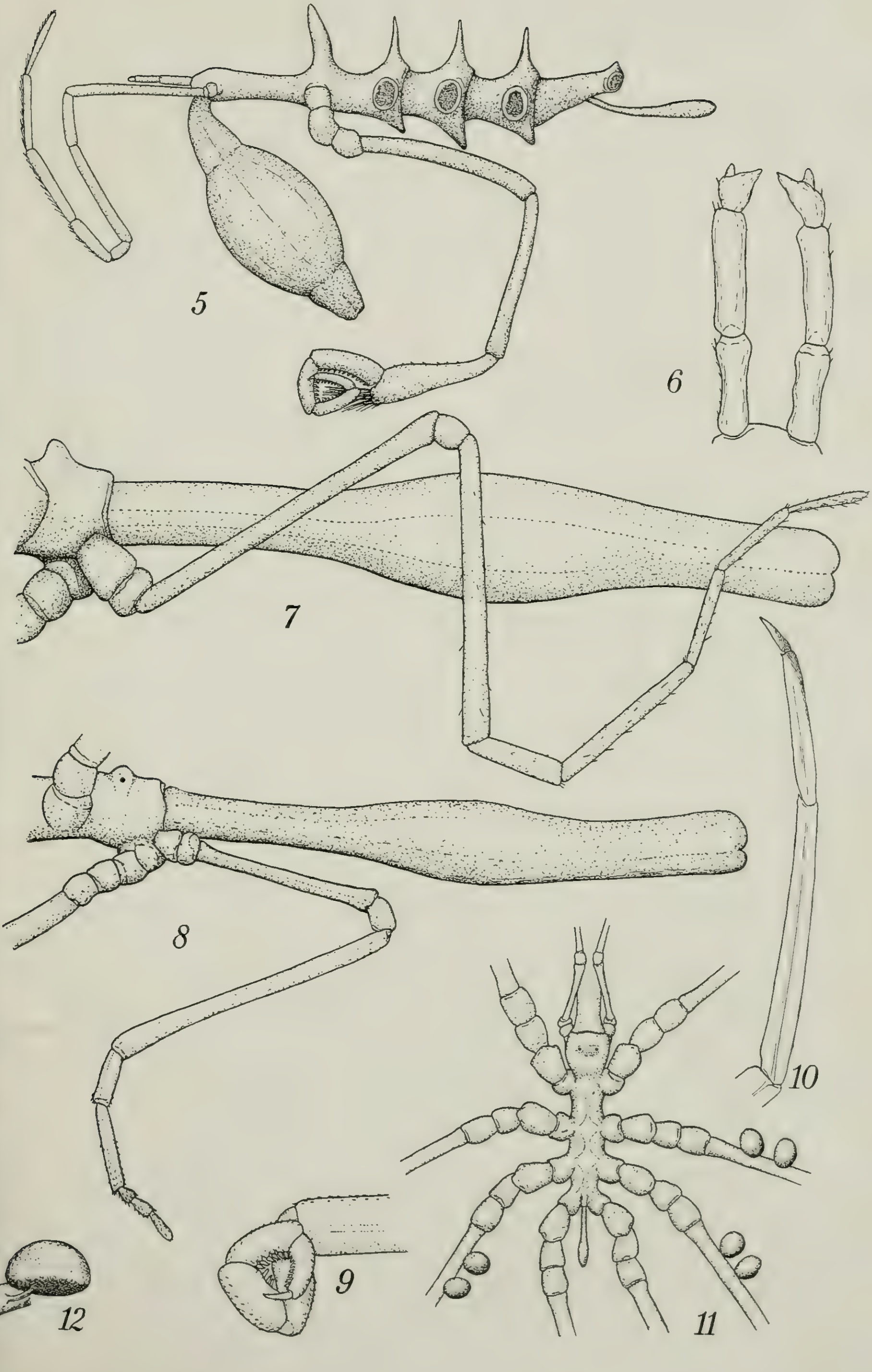
Fig. 8. *Colossendeis cucurbita*, sp. nov. Side view of anterior part of first trunk segment, proboscis and palp of same specimen as shown on pl. 2. (Compare shape of proboscis with that of *C. gigas* in fig. 7.) × 3.

Fig. 9. Terminal part of the oviger of the same specimen of *C. cucurbita*. × 6.

Fig. 10. Terminal portion of second left leg of the same specimen. × 6.

Fig. 11 Body and basal portion of legs of another specimen (*b*) of *C. cucurbita*, from above, showing foreign bodies attached to femurs of second and third legs of right side and third leg of left side. × 2.

Fig. 12. One of the foreign bodies, showing shape, and manner of attachment to the leg. × 6.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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LII. No. 12.

CRUISE OF THE U. S. FISHERIES SCHOONER "GRAMPUS" IN THE GULF STREAM DURING JULY, 1908, WITH DESCRIPTION OF A NEW MEDUSA (BYTHOTIARIDAE).

By Henry B. Bigelow.

With One Plate.

[Published by Permission of George M. Bowers, U. S. Fish Commissioner.]

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August, 1909.

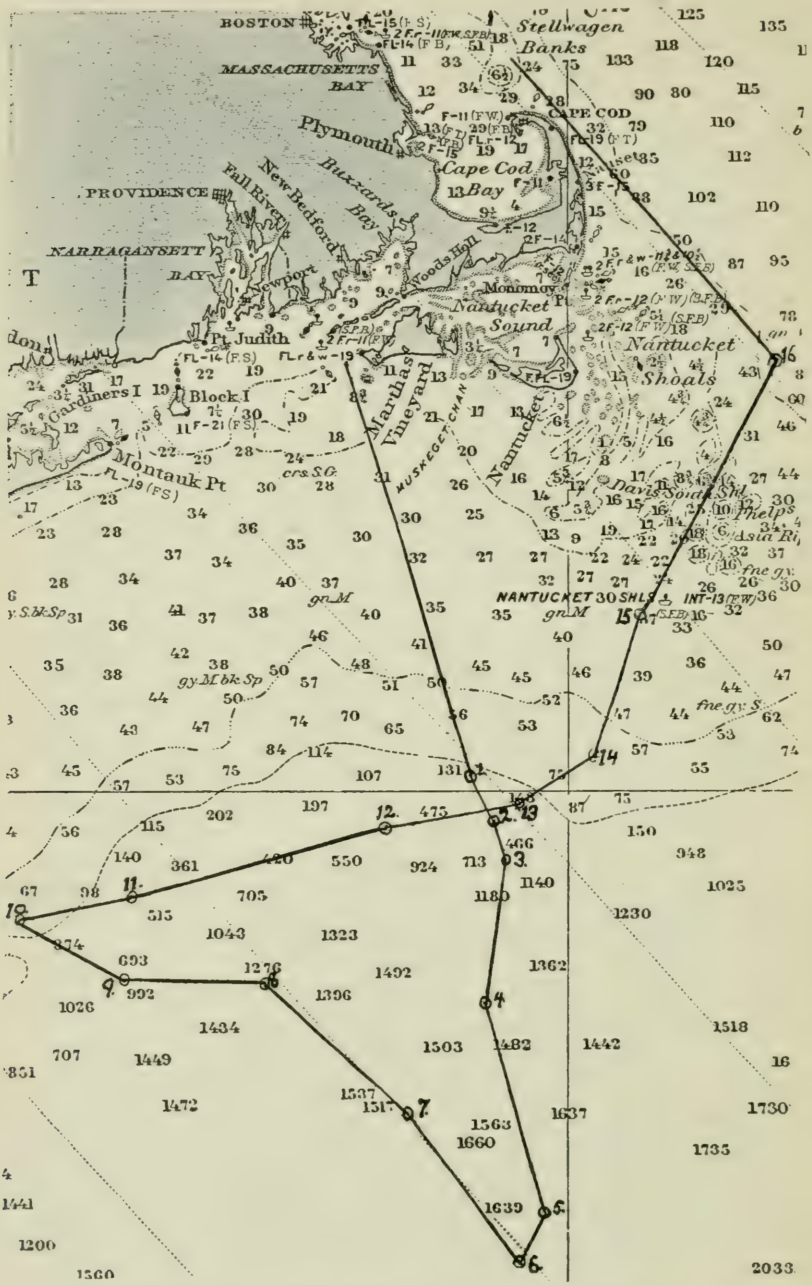
No. 12. *Cruise of the U. S. Fisheries Schooner "Grampus" in the Gulf Stream during July,* 1908, *with description of a new Medusa* (*Bythotiaridae*). By HENRY B. BIGELOW.

FROM July 7 to July 18, 1908, the schooner "Grampus" was detailed by the Hon. G. M. Bowers, U. S. Commissioner of Fisheries, for work in the Gulf Stream, under the direction of the Museum of Comparative Zoölogy.

The main purpose of the cruise was to investigate the fauna of the intermediate waters of the Stream, a branch of study which has become of great interest since the demonstration, by the recent deep-sea expeditions of the "Valdivia," the "Princess Alice," and the "Albatross," of the existence of an important intermediate pelagic fauna, distinct on the one hand from the surface fauna and on the other from the bottom fauna. This intermediate fauna was collected in great abundance by the expedition of the "Albatross" to the Eastern Pacific in 1904–1905 in the course of the Humboldt current, and in all probability it is abundant in the Gulf Stream also ; especially since certain of its characteristic components, *e. g.*, the Scyphomedusae Atolla and Periphylla, have been taken repeatedly in this region in the trawl. Up to the present time, though much surface collecting has been done in the Gulf Stream and the bottom thoroughly explored with the trawl, its intermediate depths have been almost entirely neglected.

A second purpose was a trial of the deep-sea trap devised by the Prince of Monaco. This apparatus has been employed with great success off the European coast, but had not been tried previously on this side of the Atlantic. In addition to these two main objects surface collections were made on favorable occasions and intermediate as well as surface temperatures taken.

The "Grampus" has no reeling engine, and to supply this deficiency she was equipped for the occasion with a gasoline hoisting motor, constructed by the Olds Engine Co. This apparatus, of three horse power and geared to hoist by means of a gipsy head at the rate of about 100 feet per minute, proved entirely satisfactory. From the gipsy head the wire rope was led to a hand reeling winch. The collecting apparatus consisted of several five-foot open nets, of the "Albatross" pattern, a



ROUTE AND STATIONS OF THE "GRAMPUS," JULY, 1908.

Tanner closing net of improved pattern, a Petersen closing net, the Monaco trap, and the usual complement of dip-nets and small surface tow nets. For sounding a hand Tanner machine was installed. Deep-sea thermometers were loaned by the Bureau of Fisheries.

Capt. G. F. O. Hanson, commanding, and the officers and crew were indefatigable in their attention to the work of the Cruise. Drs. L. J. Cole and J. L. Bremer accompanied me on the trip and kindly assisted in the care of the collections.

The "Grampus" set sail from Gloucester Harbor on the afternoon of July 7. On the following day we anchored in Vineyard Haven to take on board some apparatus from the Station of the Bureau of Fisheries at Woods Hole, getting under way again that evening. We purposed to make our first trial of the Monaco trap on the continental slope, near the inner edge of the Gulf Stream, and accordingly on July 9 soundings were taken at 2 P. M. in 70 fathoms and in 200 fathoms, to develop the slope. A third sounding a few miles further south showed 260 fathoms and the trap was set in about 300 fathoms. While the set was in progress an intermediate haul with the five-foot open net was made. From the Station, lat. 39° 49′ N., long. 70° 16′ W., we ran our first leg in a south-southeasterly direction for about 80 miles, to lat. 38° 33′, long. 70° 08′ (Station 6), thus making a representative section of the northern part of the Stream. On this run three intermediate hauls were made. Our second leg was run from this point on a northwesterly course, for about 120 miles, to Station 10 (lat. 39° 36′, long. 72° 15′), with three intermediate hauls. Near this point, being once more over the edge of the continental slope, we planned to make a second set of the Monaco trap. Accordingly, after sounding in 51, 300, 200, and 190 fathoms, the trap was set on July 12, lat. 39° 54′, long. 70° 44′, in 455 fathoms, the bottom at that point being green mud with a few Globigerinae. During this set, as at Station 3, an intermediate haul was made. From this Station our third leg was run in a northeasterly direction parallel to the continental slope, along the inner edge of the Stream until we intersected leg 1, near Station 3, a distance of about 90 miles, during which one intermediate haul was made. On the completion of this leg the work in the Stream proper was completed, the triangle thus executed having given us a survey of a typical region. However, in order to compare the pelagic fauna of the cold water over Nantucket shoals with that of the warm waters of the Stream, work was prosecuted on the homeward trip over the shoals and around Cape Cod, hauls being made in regions where the surface temperatures were 64° and 65°, respectively.

Throughout the Cruise the weather was excellent and, the winds favoring, we accomplished the work mapped out with greater rapidity than could fairly have been expected. On July 18 the "Grampus" returned to Gloucester.

The Surface Fauna.

During the Cruise surface hauls were made at five stations, and in addition specimens were collected in the hand nets at several other localities, while, of course, surface forms were also taken in abundance in the intermediate hauls with open nets. The most interesting feature of the surface fauna was the extraordinary abundance of Salpae in the warm water. Salpae were first encountered on July 9, a few miles south of Gay Head, where scattered individuals and a few chains were seen floating on the surface. As we approached the continental slope and the surface temperature grew higher, they became steadily more numerous, until by the time we had fairly entered the Gulf Stream they were present in greater abundance than I have ever seen them before, even in the Humboldt current where the "Albatross" encountered them in dense swarms. Throughout the three legs which we ran in the region of the Stream their quantity was enormous, and it was not until we once more entered the colder waters over Nantucket shoals on our homeward run that their numbers began to diminish. Owing to the calmness of the weather for several successive days we had an excellent opportunity to observe them. On all sides of the vessel the surface was covered with chains, up to six feet in length, as well as with scattered single individuals. And as far as the eye could penetrate, at least five fathom, they were so abundant that during several hours' watching over the stern there was never a time when several chains were not in sight beside the rudder post at once. The quantitative results of several surface hauls may give a definite notion of the abundance of Salpae. At Station 5, where we made a surface haul of ten minutes' duration, the two-foot net was filled to the brim with Salpae, and its bridle and rope festooned with chains. On several successive occasions, also, the two-foot net was completely filled after towing a few minutes. With the five-foot net it was impossible to make any surface hauls because the weight of the load of Salpae which were captured almost at once endangered the net. Even in the intermediate hauls considerable quantities were taken. Thus, in hauls with the five-foot open net, at 150 fathoms (Station 7) between three and four quarts, and at 200 fathoms to surface (Station 13) eight quarts of Salpae were taken. In these, and in every other intermediate haul, the lower part of the net was completely filled with them. The quantities in these hauls were, however, much less than would have been taken in surface hauls of like duration, indeed no more than would be gathered on the surface by the five-foot net in two or three minutes. This fact indicates that the Salpae were chiefly limited to a comparatively shallow surface zone, probably not more than 20 or 30 fathoms, and that it was on its passage downward and upward through this zone, not while being towed horizontally at from 150 to 300 fathoms, that the intermediate net captured the load of Salpae which it invariably yielded.

The diminution in the number of Salpae noted on leaving the warm water of the Gulf Stream on our homeward trip was sudden. Thus while at Station 13, lat. 39° 57′, long. 70° 13′, eight quarts were taken in an intermediate haul; in lat. 40° 7′, long. 69° 59′ (Station 14), where the surface temperature had dropped from 72° to about 70° the diminution was already marked, and at Station 15, only twenty-seven miles distant, but with a surface temperature of 64°, only two or three individuals were seen and none taken during the half hour occupied in making a tow with the five-foot net at 15 fathoms. After this point, on the run northward around Cape Cod, only a few scattered individuals were observed. I may call attention here to the fact that Salpae were unusually abundant at Woods Hole throughout the summer of 1908.

The abundance of Salpae caused the quantitative richness of the surface Plankton of the Gulf Stream to be extremely high. But, as is usually the case when any one large organism is swarming throughout a considerable period, the yields of the surface hauls were qualitatively correspondingly poor. This poverty was progressive throughout the cruise, a fact suggesting that we reached the Stream early in the swarm-period of the Salpae, and that as time progressed these rapacious organisms devoured most of the smaller forms which usually compose the bulk of the surface Plankton. Indeed, considering the volume of water strained by them, but few of the smaller copepods, pteropods, or protozoans could be expected to escape. An unusual transparency of the surface water was connected with the poverty of the finer Plankton. For example, at Station 9, where it happened that fewer Salpae than usual surrounded the ship, the five-foot net was distinctly visible at a depth of 20 fathoms.

The Plankton, aside from the Salpae, presented no unusual features, except in the absence of certain forms which are usually common. Very few pelagic fishes were taken, among them being Cyclothone, and several mictophids. Among crustaceans, schizopods, particularly Euphausiidae and Mysis, were noticeable for their abundance. Several species of amphipods occurred regularly: hyperids were common, as was Phronima of three species associated with Doliolum. Lucifer was taken on several occasions. Several species of isopods were collected; while copepods, among them Saphirina, and ostracods of several species were an important constituent of every haul. Crustacean larvae, on the other hand, were conspicuously rare, only a few megalops stages, a few stomatopod larvae, and a single phyllosome larva being taken. Annelids, even Tomopteris, usually so common in warm waters, were noticeably absent. Perhaps the best series in the collection is afforded by the pteropods, of such genera as Hyalea, Spirialis, Atlanta, and Limacina, but other pelagic molluscs were almost absent, no heteropods, and only a single specimen of Janthina being taken. Sagitta was fairly well represented› but only very few Appendiculariae were captured. There were but few coelenterates taken, and those few all belong to species widely distributed in tropical and subtropical waters. Among siphonophores I may mention Physalia, Crystallomia, Diphyes, Galeolaria, Abyla, and Rhyzophysa. The only Medusa found on the surface in the Stream was one specimen of *Rhopalonema velatum*, and the only ctenophores were a few *Beroe ovata*. The scarcity was even more striking in the case of the finer Plankton, the quantity of rhizopods, radiolarians, and diatoms in any of the hauls being extremely small. Associated with this scarcity is not only the clearness of the water already noted but the fact that throughout the cruise very little phosphorescence was to be seen.

In addition to the smaller organisms certain other surface forms deserve brief notice. Gulfweed was first noted a few miles southeast of Gay Head. It was seen in small masses so long as we were within the influence of the Gulf Stream; but after we left the Stream, as shown by the decrease of the surface temperature to 64°, no more was observed. Several small collections of Gulfweed were made, and from them the usual species of crustaceans and other animals obtained; among them I may call especial attention to Balistes, Lepas, plumularian hydroids and Obelia. A floating box yielded a rich haul, including a small Loggerhead turtle, and many specimens of a large eolid with chocolate papillae. A most interesting capture is that of two specimens of a large octopoid taken on the surface in lat. 39° 25′ N., long. 71° 48′ W. The specimens were floating dead when seen, but both were in fairly good condition and were preserved. In the larger the central disc between the bases of the arms was about 18 inches in diameter, and the tentacles were about two feet long. Both specimens were of a deep chocolate-red color. Judging from the similarity between the pigment and that of many intermediate organisms it is not unlikely that this cephalopod belongs to the intermediate fauna, and that the specimens were brought to the surface by some horizontal disturbance of the water.

Among larger surface forms flying fish were frequently noted so long as we were in the warm waters of the Stream, as were several schools of whales and porpoises. The only birds observed in the Stream were Wilson's petrels (*Oceanites oceanicus*) and the Greater Shearwater (*Puffinus gravis*).

As already noted, surface hauls were made on the homeward trip around Cape Cod for the purpose of comparing the Plankton of the cold waters with that of the Gulf Stream, and the usual characteristic differences were noted. At Station 15, a haul with the five-foot open net was made at 15 fathoms and at the surface. At this station great masses of small pink copepods were taken, as well as several specimens of the characteristic northern *Clione limacina* (Phipps), and a large quantity of Spirialis. Many small specimens of *Cyanea arctica* were noted on the surface, and several collected. The sudden absence of Salpae on passing into the colder water has already been noted. Although no remarkable forms were taken, the contents of this and the ensuing hauls, which contained much the same species, are of considerable interest from the faunistic standpoint, as showing how sudden is the demarcation between the surface faunae of the cold and warm waters off Cape Cod, the yield being composed of species entirely different from those taken in the Gulf Stream. The surface temperature at this station had already dropped to 64° and at 30 fathoms it was only 54.5°. From this point northward no more Sargassum was observed but in its place considerable masses of Fucus were seen. In this weed we took a species of Balistes distinct from the one captured in the Sargassum.

The Intermediate Fauna.

The intermediate collecting was carried on chiefly by means of hauls with a five-foot open net of the ordinary "Albatross" pattern, coarse meshed, only the last three feet being lined with bolting silk. For general work of this sort the value of a large net cannot be overestimated, and it is equally important that at least most of its surface be of coarse mesh; otherwise the passage of water is too slow and the fabric soon becomes clogged. Apstein[1] has already observed that the ordinary fine plankton net is of little service for collecting large organisms, and the same thing was experienced during the cruise of the "Albatross" in the Eastern Tropical Pacific in 1904–1905. The construction of the tail of the net should be such as to prevent its collapse with consequent injury to its contents. For this purpose a glass jar is often attached. But our experience on various expeditions has shown that it is quite as effective, and much more convenient, simply to insert between the bolting silk and outer covering a sleeve of brass wire-netting, sewing it to the outer net, and leaving enough stuff to tie up below it. This has answered every purpose, is cheap, and unbreakable.

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[1] Salpen der deutschen Tiefsee-expedition. Wiss. Ergeb. der deutschen Tiefsee-expedition, Bd. 12, lief. 3, 1906.

The Tanner closing net was also employed at one station, but caught nothing. For work on a small sailing vessel such as the "Grampus," owing to the rapid rolling and pitching, this form of closing net is much more difficult to handle than on a large vessel. Even in calm weather a schooner lurches about so violently that it is often impossible to handle any heavy apparatus requiring delicate adjustment. For this reason the arrangement of the "trigger" on the Tanner net, which has been found entirely adequate on the "Albatross," was unsatisfactory, owing to its liability to trip, with consequent closing of the net, before the latter even reached the water. To obviate this difficulty, following the example of Murray[1] who experienced the same trouble, we lashed the long upright arm of the trigger to the wire rope with weak twine. This holds the trigger firmly, but, being readily cut by the messenger in its descent, offers no obstruction to the operation of the net. To the use of the Petersen net excessive rolling introduces another but equally serious drawback, namely, the possibility of the net opening while being lowered, when it is pulled upward through the water by the reverse roll of the vessel. A second drawback to this net is that it can be operated only through a comparatively short column of water, a fact which, together with the small diameter of the mouth, seriously reduces the amount of its catch.

During the Cruise intermediate hauls were made at nine stations with the five-foot open net at various depths down to about 300 fathoms and thence up to the surface, both by day and by night, and at one station with the Tanner net. The results of this work were most discouraging. Although the net always brought back a considerable mass of material, this consisted almost entirely of species of Salpae, fishes, schizopods, amphipods, copepods, ostracods, pteropods, and Sagittae, which were taken also on the surface or in hauls at depths from 15 to 50 fathoms.

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[1] Geogr. Journ., **13**, p. 147, 1899.

It is evident, then, that the bulk of the catch was obtained by the net on its downward and upward trips through the surface zone. None of the genera of fishes, of crustaceans, of holothurians, nor of Medusae, which have been shown to be characteristic of the intermediate zone, were taken. This is the more remarkable in view of the fact that two intermediate genera of Medusae, Atolla and Periphylla, have both been taken frequently in the trawl from the region of the Gulf Stream. I am unable to explain this failure. It may be that we did not work deep enough, and this occurred to us during the Cruise, but inasmuch as our apparatus was not adapted to working at depths greater than 300 fathoms, we were unable to test this possibility. However, the experience of the "Albatross" expedition to the Eastern Tropical Pacific has demonstrated, for the region of the Humboldt current at least, that the intermediate fauna is abundantly represented in the zone above the 300-fathom line, and I see no reason to believe that the contrary would prevail in the Gulf Stream, a region in which, although temperate conditions are different, the nature of the food supply of intermediate organisms much resembles that in the Humboldt current. It is not improbable that had we worked a month later our success might have been greater.

In spite of the general poverty of the intermediate fauna, one new intermediate Medusa, a Sibogita, was taken. It is of interest not only from the systematic standpoint, but also from the circumstances of its capture. Sibogita was first taken at Station 3, where six specimens were captured in a haul with the five-foot net from 175 fathoms. At this point, which is on the coastal slope, the depth of water is about 260 fathoms, and from here the slope to the 1,000-fathom curve is rapid. Sibogita was not encountered again until Station 11, when, at about the same relative position on the slope, in a depth of 300 fathoms, another specimen was taken in a haul from 150 fathoms. The species was not met with again, although another haul was made near the locality where it was first captured. There is every reason to believe, from its near allies, that Sibogita passes through a fixed stage ; and from the present captures I believe that when discovered the hydroid will be found to be a deep-water form, living below 150 fathoms. The fact that this Medusa has never been recorded from Woods Hole or from Newport, in spite of the systematic collecting carried on for many years at both these localities, is no doubt due to its intermediate habitat, below the influence of the surface waters of the Gulf Stream which are often driven by southerly winds against the southern coast of New England.

The Monaco Deep-sea Trap.

The deep-sea trap which we employed was supplied by the United States Bureau of Fisheries, and in all respects resembled the pattern of the Prince of Monaco, except that the frame-work was constructed of galvanized iron gas pipe instead of wood. The use of the Monaco trap, like that of closing-nets, is difficult on a small vessel, but judging from the present Cruise the results which it may be expected to yield are more than commensurate with the trouble involved. I question, however, whether it possesses any superiority over the trawl, except in certain special cases. The chief difficulty on a vessel so small as the "Grampus" is the nature of the rope to be employed, if sets are to be made in depths of 500 fathoms or upward. Under these circumstances the five-eighths inch wire rope usually used in trawling is out of the question, for not only is it difficult to handle, but its great weight in water would require a float or buoy larger than could be carried. On the present trip, having no smaller wire rope, hemp "buoy line" was successfully employed; but it has the drawback of weakness, while its great frictional resistance to the water enormously increases the difficulty of hauling in the trap with a small motor. No doubt a very small wire rope, with breaking strain of about 800 pounds, would prove satisfactory. A larger one is unnecessary, since the weight of trap and sinker together need not exceed 100 pounds. The buoy should be provided with a flag of some sort on a light pole. For economy of time it would be advisable to have several traps and set them in lines; with such an arrangement there would be little danger of losing them, while the vessel might be employed with other work during the sets. For bait we used dead fish and table scraps.

In our two sets the results were as follows: at Station 3 the trap remained on bottom about one hour only. It brought back two species of fish, *i. e.*, eleven large *Myxine glutinosa*, and one *Synaphobranchus pinnatus*, as well as several specimens each of two species of large amphipods. At Station 12 the trap was on bottom for about two hours. It contained one *Synaphobranchus pinnatus*, one *Physis chesteri*, and twenty-one *Simenchelys parasiticus*. The latter species must be extremely abundant at this locality, to allow so many to find their way into the trap in so short a time, for they are but weak swimmers.

TEMPERATURES.

The few temperatures observed during the voyage are of interest as additions to the records of the temperature conditions of the Gulf Stream. The highest surface temperature was 76°, the lowest within the sweep of the Stream, 72°. The most important feature of the observations is their renewed demonstration of the shallowness of the surface layer of warm water in this region. Thus at Station 5, where the highest surface temperature (76°) was observed, at 100 fathoms the temperature was only 49.5°, a drop of over 26°. And the highest temperature observed at 100 fathoms was only 51.5°. The temperatures are shown in the table, (p. 210).

DESCRIPTION OF A NEW MEDUSA.

Bythotiaridae MAAS, 1905.

sens. em. Bigelow, 1909.

This family is of such importance from its morphologic relations on the one hand to the Tiaridae and on the other to the Williidae, that a new species is of unusual interest. More especially is this the case since up to the present time only eight individuals (representing the genera Bythotiara Guenther, Heterotiara Maas, and Sibogita Maas) have been described which can certainly be referred to it, though two other genera, Dichotomia Brooks, and Netocertoides Mayer, may find their place here. The specimens collected by the "Grampus" are typical members of Sibogita.

Sibogita MAAS, 1905.

sens. em. Bigelow, 1909.

Bythotiaridae with four primary radial canals, and in addition, numerous centripetal canals which may secondarily come to join either the cruciform base of the manubrium or the radial canals, or may remain blind. Gonads transversely folded.

Two species have previously been referred to this genus, *S. geometrica* Maas (the type), and *S. simulans* Bigelow, the first from the Malaysian region, the second from the west coast of America. From my studies on *S. simulans*[1] I maintained that the branching of the canals described by Maas in *S. geometrica* was a secondary condition, resulting from a union of blind centripetal canals with the cruciform base of the manubrium or with canals of an earlier generation. Inasmuch as a secondary junction of canals with manubrium probably occurs in *S. geometrica*, as well as in *S. simulans*, I believed that it was characteristic of the genus. In the present series, however, the centripetal canals all end blindly, although the specimens are apparently mature. This difference should not be made the basis for generic separation since it is merely a case of permanence in the Atlantic species of a character retained up to a very late stage in growth by the Pacific form; and therefore a modification of my earlier (1909) generic characterization is necessary. In the condition of the canals the specimens are much more closely related to *S. simulans* than to *S. geometrica*, but they are separated from both not only by the permanently blind centripetal canals, but also by other characters of sufficient importance to warrant the institution of a new species.

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[1] Mem. Mus. Comp. Zoöl., **37**, p. 212, 1909.

Sibogita nauarchus, sp. nov.

Fig. 1-8.

Lat. 39° 49′ N.; long. 70° 16′ W.; 175 fathoms to surface, 6 specimens.

Lat. 39° 39′ N.; long. 71° 48′ W.; 150 fathoms to surface, 1 specimen.

The specimens all have well developed gonads, in which the sexual products are apparently mature.

In general external appearance *S. nauarchus* closely resembles *S. simulans*. The specimens are, however, larger than the three recorded individuals of the latter, the largest in the present series measuring 37 mm. in height by 40 mm. in diameter, as against 30 and 22 mm. respectively for the "Albatross" specimens of *S. simulans*. The single known specimen of *S. geometrica* is described by Maas [1] as being 38 mm. high by 30 mm. in greatest diameter. The general outline of the bell is rounded; the gelatinous substance fairly thick and stiff. An important feature of *S. nauarchus* is the presence of a deep funnel-shaped apical depression, clearly shown in the type (Fig 1). This character must be regarded as normal, since it is well developed in all six specimens; and since no corresponding structure occurs either in *S. geometrica* or in *S. simulans* it is no doubt of specific significance.

Both Maas and myself have already recorded a lateral flattening of the bell in Sibogita, whereby one diameter is much greater than the other; and since such a flattening was observed in all the specimens of *S. nauarchus* before preservation it is probably normal. However, the plane in which the flattening occurs is not invariable, it being either radial or interradial. Thus, while in both the Eastern Pacific specimens of *S. simulans*, even before preservation, there was strong radial flattening (Bigelow, *loc. cit.*, pl. 5, fig. 5), in the present series the flattening is radial in two specimens, and interradial in 4. From this evidence it appears that the flattening is not a structural feature, but a contraction-phase which is readily assumed.

Manubrium. The manubrium, as in both previously known members of the genus, is barrel-shaped, about two-thirds as broad as long, and about one-half as long as the bell cavity is deep (Fig. 1), and it is readily distinguishable into basal, gastric, and labial portions. As in *S. simulans* it is cruciform basally (Figs. 2, 4).

Canal system and tentacles. The collection contains an interesting series of stages in the development of the canal system and tentacles. The number of radial canals in each of the specimens is 4, but the number and degree of development of the blind centripetal canals, such an important feature in this genus, varies, not only in different individuals but in the different quadrants of any one individual. The most rudimentary condition in any quadrant is one in which there are three blind canals, one interradial and two adradial, the interradial, which is the furthest developed, reaching nearly to the base of the manubrium (Fig. 1). Connected with each canal is a well-developed tentacle, as is shown in the photograph, and between the interradial and one of the adradial tentacles is an extremely rudimentary tentacle as yet unconnected with a canal (Fig. 3). From this, as well as from similar instances, it is evident that in the development of additional tentacles and blind canals, the tentacle is formed first, its corresponding canal appearing later. In all quadrants the largest blind canal is the interradial, a fact showing that it is formed next after the radial canals. After the formation of these three series, radial, interradial, and adradial, further development of canals and tentacles is somewhat irregular. The numbers of canals and tentacles per quadrant, together with the dimensions of the bell, are given for five specimens in the subjoined table.

---

[1] Die Craspedoten Medusen der Siboga-Expedition. Uitkom. op. Zool. Bot., Oceanogr. en Geol. Gebied. Siboga-Expeditie. Monogr. 10, p. 17. 1905.

Height mm.	Diameter mm.	Tentacles between each two radial tentacles	Blind canals in the corresponding quadrants	Flattening of the bell
33	35	4, 5, 5, 6	4, 4, 4, 3	interradial
32	35	5, 5, 4, 5	3, 4, 3, 4	interradial
30	32	6, 5, 5, 5	3, 4, 5, 4	radial
37	40	5, 5, 6, 5	4, 4, 5, 4	interradial
37	39	5, 4, 4, 5	5, 4, 4, 4	radial

One abnormality was observed in which there are two blind canals in connection with a single tentacle (Fig. 7). The greatest number of tentacles in any quadrant is six; though in this quadrant only three canals are present. The greatest number of blind and radial canals and of tentacles in any individual is twenty-one and twenty-five, respectively, in the largest specimen. None of the canals unite with the manubrium in any specimen, nor are any of them branched. The blind terminations of the canals are ordinarily simply rounded (Fig. 4); in several instances, however, they are variously lobed and dentate (Fig. 2), and it is possible that such a conformation foreshadows a future union with the cruciform base of the manubrium. In the condition of its tentacles and centripetal canals *S. nauarchus* closely resembles half grown specimens of *S. simulans*, except that in the former the number of these organs is slightly greater than in the latter. But, as I have already pointed out (p. 205) the centripetal canals in *S. nauarchus* are probably permanently blind, whereas in *S. simulans* they come, through growth, to join the cruciform base of the manubrium. In *S. geometrica* conditions in the adult, which alone is known, indicate that not only do the older generations of centripetal canals join the base of the manubrium but the youngest centripetals join the earlier formed canals, both radial and centripetal, at varying heights.

Tentacles. — In structure the tentacles resemble those of *S. simulans;* their better preservation allows confirmation of my previous description. They are hollow, distensible to a length considerably greater than the bell height, and when fully developed each bears at its tip a conspicuous nematocyst knob (Fig. 8). The tentacles do not acquire this structure until fully grown. A similar terminal knob was observed in *S. simulans* (Bigelow, *loc. cit.*, p. 215), and it is probable from Maas's description that it occurs in *S. geometrica*. The basal swellings are small (Fig. 3). In the appearance of the young tentacles in advance of the corresponding canals, *S. nauarchus* agrees with *S. simulans*. There are no ocelli, nor have ocelli been observed in this genus.

The tentacles, as in both *S. simulans* and *S. geometrica*, appear to arise from the exumbrella some little distance above the actual margin of the bell. This position, however, is only secondary, and is comparable to the exumbral origin of the tentacles in the Olindiinae. The youngest tentacles stand free upon the margin (Figs. 5–7). With growth, however, this primary position is concealed, for the tentacles turn outward and upward, coming to lie in furrows of the exumbrella, so that they apparently emerge from the surface of the bell some distance above its margin. In *S. nauarchus,* at least, their bases never become entirely surrounded by the gelatinous substance of the bell, as is the case in the Olindiinae, but the exumbral furrows remain permanently open.

Gonads. — The gonads in all the specimens are far advanced, large eggs being visible in two individuals. In their main features they closely resemble those of the two members of the genus previously known, being strictly interradial, entirely discontinuous in the perradii, and consisting of double series of narrow and rather regular transverse folds (Fig. 2). In addition to these transverse folds irregular projecting lobes are developed in three specimens (Fig. 1). Sections, however, show that such lobes are nothing more than regions of the sexual organ which have made an irregular growth outward. The sexual organs are entirely restricted to the walls of the manubrium; they leave the labial region of the latter bare.

Color. — In life the gonads were deep brownish red, the terminal tentacular knobs and basal bulbs pale yellowish.

The evidence that *S. nauarchus* belongs to the intermediate fauna, and that it is probably liberated from a deep-water hydroid, has already been given (p. 203). *S. simulans* was taken on the surface; *S. geometrica* is known only from an intermediate haul.

S. nauarchus is separated from *S. geometrica* by the fact that in the adult of the latter there are only sixteen tentacles, though there are thirty-two canals, whereas in *S. nauarchus* the number of tentacles equals that of canals or, since young tentacles are formed before the corresponding blind canals, may be slightly greater. From *S. simulans*, to which it is more closely related, it is separated by its greater size, and by a larger number of tentacles and canals. It is, moreover, readily distinguished from both previously known species by the presence of the apical depression of the exumbrella, as well as by the permanently blind terminations of the centripetal canals.

TABLE OF STATIONS.

Station	Date	Time	Latitude N.	Longitude W.	Surface temperature	Temperature at	Depth by sounding	Bottom	Nature of haul
1	1908 July 9	3 P.M.	40° 2′	70° 23′	...	....	200	grn. mud. few glob.	Sounding
2	" 9	4 P.M.	39° 55′	70° 19′	...	....	200	grn. mud. few glob.	Sounding
3	" 9	5 P.M.	39° 49′	70° 16′	71°	100 fms. 51.5°	260		Monaco trap 5 ft. open net at 175 fms. and to surface
4	" 10	8 A.M.— 12 M.	39° 20′	70° 26′	74°	100 fms. 49°	..	....	Tanner closing-net at 275 fms. 5 ft. net at 275 fms. and open to surface
5	" 10	6 P.M.	38° 40′	70° 4′	76°	100 fms. 49.5°	..	....	5 ft. net at 275 fms. and open to surface Surface haul
6	" 11	6 A.M.	38° 33′	70° 8′	75°	400 fms. 42.5°	..	....	5 ft. net at 300 fms. and open to surface
7	" 11	2 P.M.	39° 9′	70° 39′	74.5°	....	..	....	5 ft. net at 150 fms. and open to surface
8	" 11	8 P.M.	39° 24′	71° 14′	74°	....	..	....	Surface haul
9	" 12	10 A.M.	39° 25′	71° 48′	75°	....	..	....	Surface haul 5 ft. net at 300 fms. and open to surface
10	" 12	2 P.M.	39° 36′	72° 15′	75°	....	51	grn. mud. few glob.	Sounding
11	" 12	6 P.M.	39° 39′	71° 48′	75°	300 fms. 42°	300		Sounding
—	" 13	8 A.M.	40° 1′	70° 54′	73°	200 fms. 46°	200	grn. mud. few glob.	5 ft. net at 150 fms. and open to surface Sounding
—	" 13	....	....	....	...	190 fms. 46.5°	190	....	Sounding
12	" 13	3 P.M.— 8 P.M.	39° 54′	70° 44′	75°	....	455	grn. mud. glob.	Sounding Monaco trap 5 ft. net at 200 fms. and open to surface
13	" 14	2 A.M.	39° 57′	70° 13′	72°	....	..	....	5 ft. net at 100 fms. and open to surface Surface haul
14	" 14	8 A.M.	40° 7′	69° 55′	71°	....	75	grn. mud.	5 ft. net at 50 fms. and open to surface
15	" 14	3 P.M.	40° 33′	69° 44′	64°	31 fms. 44.5°	31	sand	5 ft. net at 15 fms. and open to surface Surface haul
—	" 14	5 P.M.	....	....	54.5°	....	..	....	Surface temperature Surface collection
16	" 15	7 A.M.	41° 20′	69° 10′	65°	....	70	broken shells	5 ft. net at 50 fms. and open to surface

EXPLANATION OF THE PLATE.

Sibogita nauarchus, sp. nov.

All figures are from unretouched photographs of specimens preserved in formalin.

FIG. 1. General side view of type. × 1.5.

FIG. 2. Side view of manubrium of another specimen, to show the transversely folded gonads (go), limited to the interradii, and the blind terminations of the centripetal canals. c. ra, radial canal; c. ira, interradial canal; c. ara, adradial canal; l., lip. × 3.

FIG. 3. Slightly more than one quadrant of the bell margin, with canals and tentacles. c. ra, radial canal; c. ira, interradial canal; c. ara, adradial canal. In the quadrant there are three young tentacles (t^2), in connection with which no canals have yet been developed. × 4.

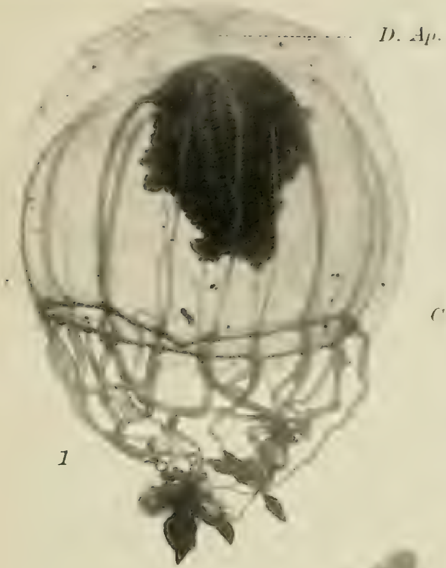
FIG. 4. Aboral view of the apex of the bell in a specimen in which the manubrium has been dissected away, to show the blind terminations of the centripetal canals. Lettering as in Figs. 2 and 3. × 2

FIG. 5. Portion of margin, oral view, showing a young tentacle (t^2), in connection with which no canal has yet been developed. × 10.

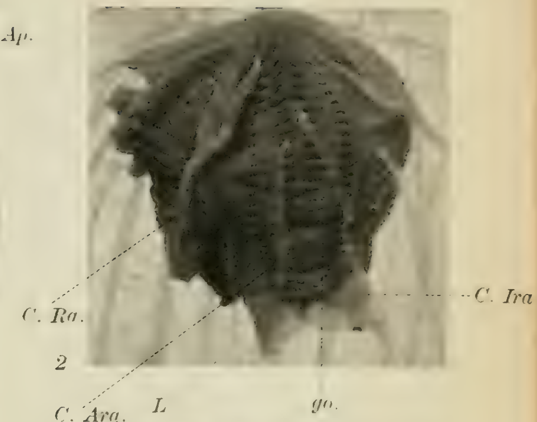
FIG. 6. Similar view of a somewhat older tentacle (t^2), with a short centripetal canal, (c^2). T^1, fully developed adradial tentacle. C^1, adradial canal. × 5.

FIG. 7. An abnormality, in which two blind canals have been developed in connection with a single tentacle (t^2). × 5.

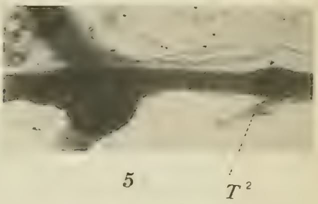
FIG. 8. Terminal tentacular nematocyst knob, from fully developed tentacle. × 15.



1


C. Ra.
C. Ira
C. Ara.
L
go.

2



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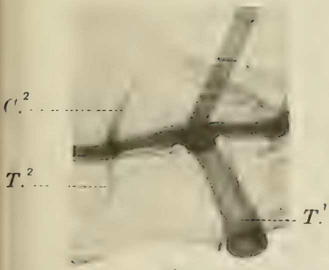

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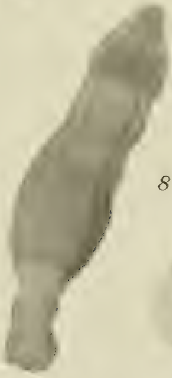
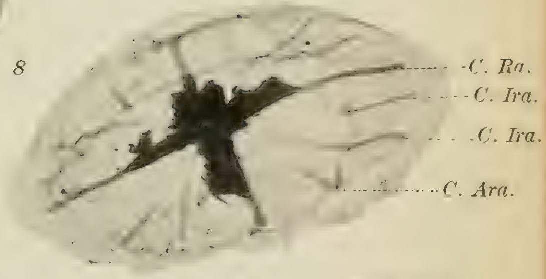
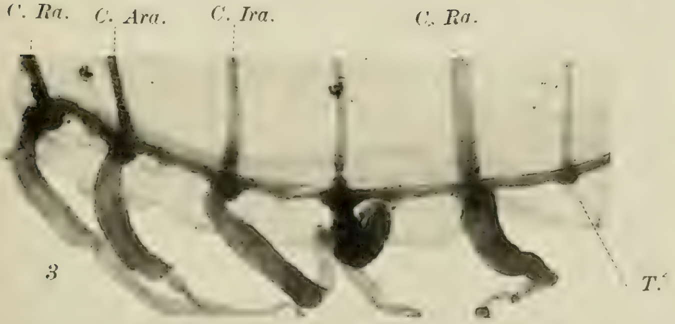


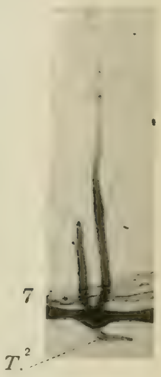
8


C. Ra.
C. Ira.
C. Ira.
C. Ara.

4


C. Ra.
C. Ara.
C. Ira.
C. Ra.
$T.^1$

3



7

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REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XX.

MUTATIONS IN CERATIUM.

BY CHARLES ATWOOD KOFOID.

WITH FOUR PLATES.

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XX.

Mutations in Ceratium. By CHARLES ATWOOD KOFOID.

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NORMAL SCHIZOGONY IN CERATIUM.

Throughout the genus Ceratium asexual reproduction occurs, in so far as is known, exclusively by schizogony. Multiple spore formation such as is seen in some other genera of dinoflagellates, as for example in Pyrophacus, is, as yet, entirely unknown. This schizogony takes the form of an oblique fission of the entire organism whereby not only the nucleus and cell plasma are divided but the parental skeleton as well.

Division of Ancestral Skeleton.

This skeleton is made up of a definite number of plates with a typical arrangement throughout all the species of the genus. It is parted at schizogony along existing sutures between the plates by the fission plane which is oblique to the major axis, passing at an angle of approximately 45° from the right anterior shoulder of the midbody to the left posterior region at the outer side of the base of the left antapical horn. By this process the ancestral skeleton is parted (see plates **1** and **2**) so that the anterior schizont receives apical plates 1′–4′, precingulars 1″ and 2″, the two girdle plates between the proximal end of the girdle and a point near the middorsal line, and postcingular plates 1‴–3‴, in all 9 plates together with the proximal half of the girdle and anterior moiety of the so-called ventral plate. The posterior schizont receives precingulars 3″–4″, the two girdle plates between its middorsal gap and its distal end, postcingulars 4‴ and 5‴ and antapicals 1⁗ and 2⁗; in all 6 plates, the distal half of the girdle and the posterior moiety of the ventral "plate." The ventral plate, as Lauterborn (1895) has shown, is divided between the two schizonts by a more or less oblique line, which passes from the flagellar pore at the proximal end of the girdle to the attachment area at its distal end. The position of the fission plane with reference to the skeletal plates was correctly given by Bütschli (1885) and Bergh (1886). but the number and position of the plates are not completely or correctly given by either author. The plates composing the skeleton and the nomenclature here used were described by me in a recent paper (1907 b).

Formation of New Skeletal Parts.

As the schizonts diverge after nuclear division, their exposed plasma adjacent to the fission plane is moulded into the form of the completed epitheca and hypotheca and is coincidently reclothed with a thin hyaline pellicle, which in a short time shows the pores and arrangement of suture lines and plates characteristic of the species. The newly formed skeletal parts, as I have shown elsewhere (1908), take on the facies of the parental individual; that is, if the parental skeleton was of a coarse-ribbed and rugose type or of a more delicate and hyaline cast, the newly formed plates of the daughter schizont are speedily thickened and their surface diversified to a degree corresponding to that of the parental skeleton by a sort of compensatory growth. The whole process is a relatively rapid one, with the exception that the prolongation of the apical horn to the full length normal to the isolated individual is often delayed as in all the individuals, save the anterior one only, in a chain of *C. vultur* shown in plate **4**, fig. 7. The result of this normal process of schizogony is the formation of schizonts which are, in all essential details, of similar form and structure. An illustration of this phenomenon is seen in this chain of *C. vultur,* where a series of schizonts of at least the fifth generation are seen still in chain. All exhibit the same form of midbody, essentially similar spread of horns with like major flexures near their bases. The cell wall even of the youngest skeletons is thickened to a like extent and in homologous regions, and all of the anterior horns have lateral lists, as does the ancestral skeleton seen in the epitheca of the anterior schizont.

Similarity of Normal Schizonts in Chain.

The differences between the cells in a normal chain consist of varying lengths of the apical horn (though this is often surprisingly uniform) ; differences in the length of the antapicals, which in the case of very long-horned species, such as *C. carriense,* are often considerable ; differences in the major flexures or spread of the antapical horns resulting possibly from juxtaposition in chain formation, and slight differences in the texture of the skeleton and the degree of development of ribs and lists upon its surface arising during the rapid process of compensatory growth. Most, if not indeed all, of these differences fall either in the category of growth or age differences or individual fluctuating variations. When measured and plotted, their dimensions form a normal frequency of error curve. I have made such measurements and plots for a number of the species of Ceratium on ten to a thousand individuals, and find that these differences conform typically to the so-called fluctuating type of variation.

The chain of *C. vultur* (plate **4**, fig. 7) is a fair representative of the usual degree of variation. I have found as high as twenty individuals in chain of this species, which is one prone to chain formation, with no greater variation than that shown here. Extremes of variation in individuals in chain are to be seen in Pouchet's (1894, p. 171, fig. 13) figures of chains of 3 and 4 schizonts, but even here the differences are strictly of the kinds above mentioned.

In sharp contrast with most Protozoa (notable exceptions appear in linear arrangement of recent schizonts of Spirochaeta and Trypanosoma) and even most of the dinoflagellates, the schizonts of Ceratium have a tendency, more or less pronounced, to adhere in chain for some time after schizogony. This tendency is more marked in some species than in others. For example, in the subgenus Euceratium Gran in the species *C. vultur*, *C. schranki*, *C. carriense*, and *C. palmatum*, chains of 4–20 individuals are not unusual, while in *C. furca*, *C. fusus*, *C. biceps*, and other representatives of the subgenera Biceratium and Amphiceratium rarely more than two individuals (except in *C. candelabrum*) are seen in chain and chains are relatively infrequent. Chain formation is most readily found in collections made in the night or in the early morning. In my own experience at San Diego (latitude 32° 40′) they are most abundant in collections made between 3 and 7 o'clock in the morning, cell division seeming to be favored by the conditions of illumination and possibly by the falling temperature prevailing during the night. The schizonts part company shortly after the completion of schizogony and skeletal formation, and chains are absent or relatively rare in collections made later in the day.

The morphology of chain formation is correlated with the presence of an apical pore at the end of an apical horn. As the new skeletal moieties are formed respectively on the posterior and anterior regions of the diverging schizonts, the plasma of the posterior member is drawn out in a long strand which becomes the apical horn. Its tip rests immediately upon the distal end of the newly forming girdle (plate 1), at which point the plasma of the two individuals remains in continuity without interference by the forming skeleton. As the newly forming skeletons are completed, the apical pore of the posterior schizont is set under the anterior shelf or list of the distal end of the girdle at the margin of the ventral plate (plate 1) of the anterior schizont. The posterior list of the girdle is not formed at this point, and the apical horn as it passes posteriorly lies in a channel or depression on the ventral face of the midbody along the right margin of the ventral plate. The place of junction on the anterior schizont I designate as the attachment area (att. a.) and the depression as the chain channel (ch. ch.). The anterior end of the apical horn is also modified, its ventral side being prolonged in a short lobe, giving to the apical pore an irregularly oblique opening (Entz, 1905), a condition found in individuals in chain and also in those but recently released from chain formation. In most free individuals the apical pore is transverse, as in the anterior parental skeleton of the schizont I_3 in the chain shown in plate 1.

In the course of my investigations upon the dinoflagellates of the Pacific conducted for the past eight years at the San Diego station and upon the collections of the "Albatross" in the tropical Pacific and elsewhere, many instances of chain formation have come under my observation. They have always been of interest and have received close inspection, and many are recorded in my unpublished sketches, especially those having any bearing on the question of variation in Ceratium. Hundreds of such chains have been inspected by myself or my assistant, Miss Rigden. With the exception of three instances noted later these chains have been of the normal type described above. The material examined from San Diego covers all seasons of the year and depths from 0–500 fathoms, and that from the "Albatross" includes collections from Alaska waters, the coast of California, and from the Expedition to the Eastern Tropical Pacific extending southward to Easter Island in the South Pacific, and from depths of 0–800 fathoms. My material is therefore fairly representative of Ceratium in its oceanic and neritic environments within the range of conditions of the normal distribution of the genus.

The literature of the subject prior to 1908 contains but few references to chain formation beyond those of Michaelis (1830), Allman (1855), Murray (1882), Pouchet (1883, 1885, and 1894), Bütschli (1885), Bergh (1886), Schütt (1895, 1896), Karsten (1905, 1906, 1907), and Entz (1907). In all these cases the type of chain formation is the normal one above described.

The Genus Ceratium.

The genus Ceratium is a large one of wide distribution in the plankton of fresh water and the sea. Most of the species are also of wide distribution and some are cosmopolitan. They exhibit a wide range of variation in many cases, especially in length and differentiation of the horns, their principal organs of flotation, in adaptation to varying conditions of life. No less than 290 different names have been given in this genus in recognition of the species, subspecies, and other subordinate categories in which the forms have been classified. In the opinion of the writer probably not less than two thirds of these are based upon growth, age, or temperature characters, while the remaining third are well founded; but even so, the degree to which the biological process of speciation has progressed in this genus is, in comparison with other dinoflagellates, except Peridinium, relatively great, a fact of possible significance in connection with the phenomenon of mutation herein described. All of the species of the genus, with the possible exception of a few numerically rare and structurally widely divergent species, fall into five sharply defined subgenera as follows : —

Tripoceratium, subgen. nov.

Antapical horns subequal, reflected anteriorly, their tips symmetrically pointed closed. Apical horn differentiated abruptly from the rotund midbody. Postmargin rounded, no postindentation. Over 25 species. C. *tripos*, *C. arcuatum* (fig. A).

Macroceratium, subgen. nov.

Antapical horns, subequal, reflected anteriorly, their tips truncate, open, or contracted or rounded, but usually with terminal pore. Apical horn differentiated abruptly from more or less rotund midbody. Bases of the antapicals projected more or less posteriorly beyond midbody forming a postindentation. Over 25 species. *C. macroceros*, *C. gallicum* (fig. B), *C. vultur* (plate **4**, fig. 7).

Biceratium Vanhöffen.

Antapical horns more or less unequal, deflected posteriorly, their tips pointed, closed. Apical horn differentiated or tapering from the midbody. Deep postindentation. Over 10 species. *C. furca*, *C. pentagonum* (fig. C), *C. californiense* (plates **1–3**, plate **4**, fig. 4).

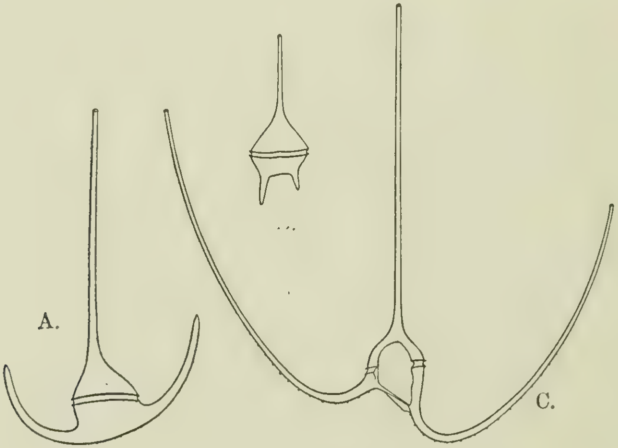


Fig. A. *Ceratium arcuatum*, dorsal view. × 155.
Fig. B. *C. gallicum*, ventral view. × 155.
Fig. C. *C. pentagonum*, dorsal view. × 155.

Amphiceratium Vanhöffen.

Antapical horns directed posteriorly, their tips pointed, closed; the right minute or suppressed, the left and the apical greatly elongated. Midbody usually gradually merging into the apical horn. Several species. *C. fusus.*

Poroceratium Vanhöffen.

Antapical horns subequal, directed posteriorly. Midbody extends to apical pore. Apical horn not differentiated. A few species. *C. gravidum.*

The subgenera Tripoceratium and Macroceratium together form the group designated by Gran (1902) as the subgenus Euceratium, but it seems best to recognize as subgenera the two large natural groups of species contained therein and easily separable on fundamental structural characters. The *C. tripos* and *C. macroceros* sections have been recognized in various ways, though not hitherto as subgenera, by recent systematists, as, for example, by Ostenfeld (1903), Pavillard (1907), Karsten (1907), and Paulsen (1908).

The number and relation of the skeletal plates are similar in all the subgenera. I have therefore (1907 b) considered this fact as the justification for keeping this large genus intact, since skeletal plates constitute generic characters throughout the family Peridinidae, to which Ceratium belongs. Amphiceratium and Poroceratium are more aberrant subgenera in which the tripartite form of the skeleton prominent in the others is considerably obscured by specializations for flotation. The other three subgenera, Tripoceratium, Macroceratium, and Biceratium, are less divergent and not so aberrant. They contain the simpler and presumably more primitive species. These also contain the greater part of the species in the genus and are separated from one another by fundamental structural features, such as the direction and curvature of the antapical horns and the forms of their distal ends, which are not so patently adaptive modifications. Should these characters alone be used as a basis for the subdivision of the genus, it would necessitate the inclusion of Amphiceratium and Poroceratium in the subgenus Biceratium. The morphological basis upon which these three principal subgenera rest is thus of general import throughout the genus.

The mutations discussed in this paper connect the three fundamental subgenera, Tripoceratium, Macroceratium, and Biceratium. *Ceratium* (*Tripoceratium*) *tripos* mutates to *C.* (*Biceratium*) *californiense,* and

C. (*Biceratium*) *californiense* is found in chain with *C.* (*Macroceratium*) *ostenfeldi.* Both the amplitude and the direction taken in these abrupt changes in form are of great interest, and are, I believe, of profound significance in their bearing upon the question of the method of organic evolution in nature.

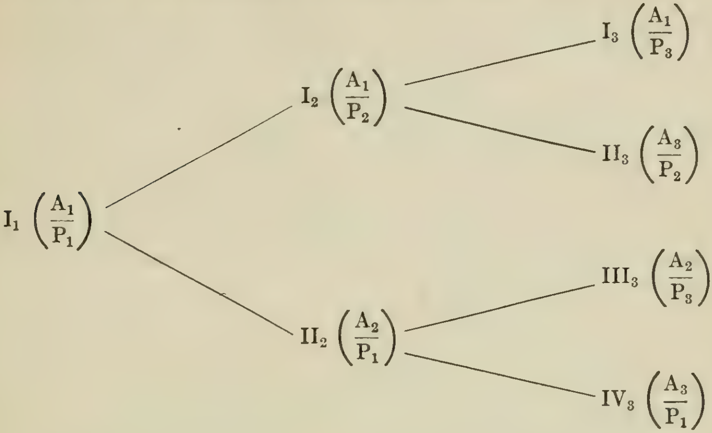
The species in or between which these mutations occur are well-established species of the genus, have a wide distribution in the sea, and in the main, excluding questions of synonymy, a general recognition in the literature of the subject. The evidence of this abrupt change in form, this mutation, or perhaps we may even say transmutation, of species seems unequivocal. The facts upon which these conclusions rest are as follows.

THE MUTATION OF CERATIUM TRIPOS TO C. CALIFORNIENSE.

The chain exhibiting this change (plates **1–3**) was taken at 8 A. M. Jan. 24, 1905, at Sta. 4737, 19° 57′ 30″ S., 127° 20′ 18″ W., on our line between the Galapagos Islands and Manga Reva in an intermediate haul from 300 fathoms to the surface. It consists of four individuals in a chain which has resulted from two succeeding cell divisions. The four individuals are in the third generation, that is, are granddaughter cells of an original grandparent cell. The original skeleton of the grandparent cell is now widely severed, its anterior moiety forming the forward armor of the foremost (uppermost in the plates) individual, and its posterior moiety the rearward shell of the hindmost (lowermost in the plates) in the chain.

Chronology and Nomenclature of Skeletal Parts of Chain.

An analysis of the chronology of skeletal formation and the distribution in the present chain of the skeletal parts formed in the three generations is illustrated in the accompanying diagram in which A_1 A_2 A_3 and P_1 P_2 P_3 represent the anterior and posterior moieties of the skeletons formed on the first, second, and third generations respectively. For convenience in referring to the individuals in the following discussion they are numbered from the anterior end posteriorly, with the distinguishing number of the generation added as subscript; thus the individual I_3 is the first (foremost) individual in the third generation, and its skeleton $\frac{A_1}{P_3}$ consists of the anterior moiety of the grandparent cell of the chain and a posterior moiety formed at the latest division. It is patent that each individual possesses one moiety of the latest generation, while the other has descended from some antecedent one.


$I_3 \left(\frac{A_1}{P_3}\right)$
$I_2 \left(\frac{A_1}{P_2}\right)$
$II_3 \left(\frac{A_3}{P_2}\right)$
$I_1 \left(\frac{A_1}{P_1}\right)$
$III_3 \left(\frac{A_2}{P_3}\right)$
$II_2 \left(\frac{A_2}{P_1}\right)$
$IV_3 \left(\frac{A_3}{P_1}\right)$

An inspection of the figures on plates **1–3** and a comparison of the skeletal conditions there presented makes it evident that the present chain reveals, by virtue of the existence of fixed skeletal parts passed by "down inheritance," the skeletal morphology for three generations. The chains of Ceratium offer thus a unique opportunity for the study of pedigree cultures in relatively simple organisms. The species characters in Ceratium lie mainly in the skeletal parts, and these are so preserved in later generations that the skeletal morphology of a line of descent may be traced with a degree of certainty unsurpassed in other organisms. The genetic connection of the members of the chain is insured beyond all question, a condition difficult to realize where the schizonts are separated at the close of cell division. Furthermore there can be no possibility of accidental contamination of a culture from air-borne spores or encysted forms such as must always attend pedigree culture work with most flagellates and ciliates.

Genuineness of the Chain.

This is, beyond all question, a genuine chain of genetically related Ceratium formed by schizogony with skeletal and plasmatic continuity, as is usual in chain formation. It is not a chance assemblage of individuals, jostled together in the crowded collection. Neither is the posterior member of the series accidentally attached to a chain of unrelated origin. The following facts sustain this assertion: —

(1) The chain has held together not only during the more or less violent disturbances involved in making a plankton haul with a silk net from a vessel at sea, but also during the microscopical examination in the course of which it has been rotated several times in freeing it from entangling organisms and in securing dorsal and ventral views. It has also survived the changes of fluid incident to the staining process and a final transfer from a 4 per cent solution of formalin in sea water through alcohol grades to glycerine, made by passing the fluids through beneath the cover glass. In the course of these changes it has been subjected to some bending and strains, but has not parted except as shown (plate 3) in the figure of the cell contents, where the junction of cells II_3 and III_3 is slightly disconnected.

(2) The connections between the apical horns of II_3, III_3, IV_3, and the attachment area at the distal ends of the girdles of I_3, II_3, and III_3, respectively, are both normal and typical. I have studied with especial care under the oil immersion lens the details of the most important connection, namely, that between the apical horn of IV_3 (*Ceratium tripos* representative) and the cell (III_3 = *C. californiense*) to which it is attached anteriorly. This is in all respects perfectly typical, even the protoplasmic bridge appearing to be still intact.

(3) The apices of all the horns, save the ancestral one, which is on the anterior skeletal moiety of I_3, exhibit the flaring, slightly lobed margin about the apical pore, described by Entz (1905), which is characteristic of this part of recently formed anterior horns. These are the conditions to be expected in a normal chain of four individuals.

(4) Contrasts in the hyalinity and porulation of the anterior and posterior moieties of the skeletal wall of the several individuals are indicative of recent normal chain formation. These differences are due to the fact that the skeletal wall grows darker with age and its pores are more easily seen. This is plainly noticeable in the case of III_3 and IV_3, upon whose recent separation by division the whole point of this communication rests. The anterior skeletal moiety of IV_3 in the original specimen is very plainly of a more delicate texture than the posterior one, barring only the right antapical region which has apparently recently exuviated or is undergoing resolution. The posterior moiety of III_3 is likewise of a lighter texture than the anterior one of that individual, though the difference between them was less striking than in the case of the two regions of the skeleton of IV_3. These contrasts are just such as would appear if III_3 and IV_3 had recently originated by the division of the posterior member of a chain of two schizonts. Differences of similar im-

port can also be detected between the older and newer skeletal parts on the two sides of the line of fission in the anterior pair, I_3 and II_3, of the chain.

(5) Finally, the nuclear conditions within the cell body (plate **3**) in all four individuals are prophetic of another division. It was not possible in the unsectioned preparation to make out finer cytoplasmic structures within the skeletal wall, but the nuclei have either completely divided (IV_3) or nearly so (III_3) or are plainly in the process of division (II_3 and I_3). The division stages here shown are similar to those which Lauterborn (1895) has found in *C. hirundinella*, a fresh-water species, and are in all respects of the normal type. There is an apparent progression in the stage of mitosis from the anterior schizont posteriorly.[1]

No structural feature is apparent in the individual cells to which this difference in mitotic activity can be traced. There is, for example, no corresponding series of differences in volume of the cell mass, or in ratio of nucleus and cytoplasm. It is possibly of interest in this connection to note that division has progressed farthest in the posterior cells of the chain, those which in normal locomotion are bathed in water which receives the waste products of the more anteriorly located members of the chain. Locomotion occurs in chains of Ceratium even during division, for the flagella persists during the process of schizogony (see Lauterborn, 1895). I have myself seen chains in locomotion with active flagella in recently collected plankton, quite contrary to the observations of Murray and Tizard (1882).

Completeness of the Chain.

Not only is this a genuine chain, but it is in all probability a complete chain. The presence of a long anterior horn with squarely truncate tip upon the foremost cell of the chain is conclusive evidence that the chain is complete in that region, that is, that no schizonts have cut loose from the chain at this end during the present cycle of schizogony. The tip of all young apical horns is peculiarly asymmetrical in adaptation to chain formation. The fact that the antapical horns of the hindmost member of the chain have undergone autotomy is also suggestive that this end of the chain is likewise complete. As I have shown elsewhere (1908), autotomy occurs not infrequently in isolated Ceratium in the plankton, but I have never seen it in Ceratium in chain. Autotomy possibly occurs only under conditions unfavorable to normal cell division. Because of this autotomy and the characters of the posterior skeletal moiety P_2, I regard the posterior end also of the chain as complete.

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[1] In view of the many discussions over the direction of the plane of division among flagellates, especially in parasitic forms such as Spirochaeta and Trypanosoma, it is of interest to note here that during the process of mitosis the equatorial plane or cleft between the parting chromatin masses shifts from approximately a longitudinal position to one at 45° to the major axis. The seemingly oblique division of the dinoflagellates is thus in its relation to the position of the nucleus prior to mitosis, a *longitudinal* one. It is, however, oblique in the skeleton and also in the plasma, unless the latter shifts with the nucleus.

It is a fact, which I have frequently observed in crowded plankton collections, that the dinoflagellates, Ceratium among them, often tend to cell division (often abortive) under the adverse conditions presumably prevailing in such collections. It seems improbable, however, that this division approaching in the chain shown in plates **1–3** was brought on by the treatment to which they were subjected in the process of collection, for it is far advanced in division, and moreover it was our custom on the "Albatross" Expedition to fix the catches of the fine silk nets very shortly after they were brought aboard, after a brief preliminary treatment with chloretone.

Evidence of Mutation.

Turning now to a detailed consideration of the data afforded by the chain shown in plates **1–3**, we find that it consists of four individuals, the rearmost of which (IV_3) is *Ceratium tripos* or a closely related species belonging to the subgenus Tripoceratium, while the other three belong to the subgenus Biceratium, to a species which I have recently (1907 c), described as *C. californiense.* The characters which determine the species in question lie in the main in the posterior part of the organism. The anterior moiety of the skeleton contains here no easily recognizable specific characters. It is impossible to determine with certainty the species of the rearmost member of the chain, since its antapical horns have undergone autotomy, the right horn having been severed by a section plane close to the midbody and the left at a distance of 0.5 of a transdiameter (at the girdle) from the midbody. This entire or partial removal of the antapical horns obscures in this individual the species characters which in the subgenus Tripoceratium are largely found in the curvature and position of these horns. There is no doubt, however, that the posterior moiety of the skeleton of the rearmost cell (IV_8) is that of the Tripoceratium type. The species was probably one with broadly evenly curved horns such as *C. arcuatum*, *C. schranki*, if not indeed *C. tripos* (*s. str*) itself. It will suffice for present purposes to designate it as *C. tripos*.

The other three members of the chain are of a different type. The differences lie in the following characters: (1) The antapicals are unequal, (2) posteriorly directed with some lateral curvature, and (3) the apices except in II_3 taper to sharp tips. (4) There results from the posterior direction of the horns a deep postindentation with sharply defined rectilinear postmargin. In *C. tripos* (cf. Fig. A), on the other hand, antapicals are curved anteriorly to a direction subparallel to the apical and their tips are abruptly pointed. There is no postindentation, and the postmargin is broadly curved with no sharp limits. The differences between the two types are profound and coincide with the distinctions between the subgenera Tripoceratium and Biceratium. The three forward members of the chain I_3, II_3, and III_3 belong to the species *C. californiense*. In cell II_3 the antapicals are distally curved outwardly a little more than in I_3 and III_3, and the tip of the right is bluntly rounded and that of the left abruptly pointed, but not in the *C. tripos* fashion with a median symmetrical point, but with a sharp point at the *outer* margin, a feature found in many other species of the subgenera Biceratium and Amphiceratium, but not in those of Tripoceratium.

The species *Ceratium californiense* was originally described by me (1907) from the waters of the Pacific off San Diego. It occurs throughout the eastern tropical Pacific in the material of the "Albatross" Expedition. It has also been recorded from the Indian Ocean by Karsten (1907). It is in my own experience a relatively rare species, occurring sparingly in the plankton. There are many such species in the different subgenera of Ceratium. The species *C. tripos* and *C. ostenfeldi* are, however, common species of wide distribution in all seas save polar waters.

Progressive Perfection of the Mutant.

The form of individual II_3 is of great interest and possibly of considerable significance. The wider spread of the horns and the absence of the tapering tip bring this individual somewhat nearer than I_3 and III_3 to the ancestral type, though neither curvature nor tip is like that of *C. tripos*. It looks as though there were some subtile ancestral influence which at the first division (I_1 to $\frac{I_2}{II_2}$) tended, though unsuccessfully on the whole, to prevent the complete saltation from *C. tripos* to *C. californiense*. Two generations (asexual!) are here required to perfect the mutation.

The relations of this phenomenon are best understood when one reconstructs the two antecedent generations from their skeletal parts distributed in the third. This can readily be done by a comparison of the formula on p. 221 and plates **1** and **2**. The ancestral individual of the chain was a *C. tripos* with skeletal parts A_1 and P_1 now on individuals I_3 and IV_3. Its daughter cells were I_2 and II_2, the first with skeletal parts A_1 and P_2, the second with A_2 and P_1. Thus the anterior member (I_2) of the chain with two individuals had the anterior moiety (A_1) of the original *C. tripos* skeleton and a new posterior moiety (P_2) which was fundamentally of the Biceratium type, but the newly formed skeletal parts were still subject to a lingering influence that shows unmistakable relations to the ancestral Tripoceratium type. In the next division, in which I_2 forms $\frac{I_3}{II_3}$, and II_2 forms $\frac{III_3}{IV_3}$, the newly formed posterior moieties (P_3 in I_3 and III_3) attain the typical form of *C. californiense* while P_2 is passed to II_3. The posterior skeletal moieties containing the most clearly defined subgeneric and specific characters P_1, P_2, and P_3 thus form a *short* series with the most abrupt change between P_1 and P_2 and record a complete transformation in the short space of three generations (two cell divisions), from the species *C. tripos* to the species *C. californiense*, and from the subgenus Tripoceratium to the subgenus Biceratium.

The chain shown in plates **1–3** was discovered in material preserved in formalin. Its further development had been stopped in the very act of a third division. What might have resulted from this division cannot be told. The fact that three of the four daughter cells are of the type of *C. californiense* and that the two generations show a movement in the direction of the perfection of that type suggests its probable continuance.

Significance of Autotomy and Resolution of the C. tripos Skeleton.

The condition of the skeleton of the *C. tripos* cell, especially of its posterior moiety P_1, is also most suggestive. Not only have the horns undergone autotomy, but there is evidence that the skeleton is being further modified. The wall of the left antapical horn and that of the right antapical region (Plate 2) is exceedingly thin and tenuous, and the pores are scarcely visible, as though the wall had been thinned down by a process of solution. This condition is in sharp contrast to that of the unmodified ancestral skeleton in the rest of the posterior skeletal moiety P_1. This has a heavier, less hyaline wall whose pores become gradually fainter in the more distal parts. It thus appears that the ancestral skeletal moiety, *i. e.* of *C. tripos*, of this posterior member of the chain is gradually disappearing. In all other structural features and in the process of cell division this member of the chain appears to be a normal cell. The question naturally arises, will this process continue until the old skeleton is entirely lost and will a new skeleton of the *C. californiense* type be formed in its place? This cell IV_3 is a sister cell of a *C. californiense* III_3. Is not its inherited skeleton of the *C. tripos* type, and are its nucleus and plasma now, and perhaps since the first division, of the *C. californiense* type? Only pedigree cultures can give a decisive answer to these interesting questions.

THE MUTATION BETWEEN CERATIUM CALIFORNIENSE AND C. OSTENFELDI.

PLATE 4, FIG. 4.

Another chain was taken in the intermediate haul from 800 fathoms to the surface at 8 A. M. on December 31, 1904, at station 4711, 7° 47′ 30″ S., 94° 5′ 30″ W., on our line between Easter Island and the Galapagos Islands. The chain consists of two individuals only. The anterior member of the chain is a *Ceratium ostenfeldi*, the posterior is *C. californiense*. The anterior member has the antapical horns recurved anteriorly with truncated open tips. Their bases are also projected posteriorly, forming a deep postindentation and a long straight postmargin. These are characters of the subgenus Macroceratium. The posterior member has the antapical horns projected posteriorly, with slight outward curvature, a characteristic of the species (*C. californiense*), with tapering pointed tips and deeper postindentation, characteristics of the subgenus Biceratium. The mutation here involves the two species *C. ostenfeldi* and *C. californiense*, belonging to two of the important subgenera of the genus, Macroceratium and Biceratium. The anterior cell of this chain has the characteristically open tips of the subgenus Macroceratium. The extruding plasma (plate **4**, fig. 5) leaves no doubt on this point. The typical proportions of the three horns and the general habitus of the cell suggest that it is a normal cell, not an autotomized one Owing to the state of development in which the relatively short horns of the anterior member of this chain appear, its specific identity is somewhat obscured. I have referred the cell to the species *C. ostenfeldi* rather than to *C. macroceros*, because of the distance to which the major flexures in the bases of the antapicals are projected posteriorly. This is much greater in *C. macroceros* and much less in

C. intermedium, especially in the left horn, than it is in *C. ostenfeldi*. Compare on this point the original figure of *C. macroceros* (Claparède et Lachmann (1858–1861, plate 19, fig. 1), Ostenfeld's (1903, p. 584, figs. 136–139) figures of *C. intermedium*, and Kofoid's (1907 c, plate 26, figs. 22–25) of *C. ostenfeldi*. The three species here named form a group of closely related but clearly separable species, much confused in the earlier and some of the recent literature (see Paulsen, 1908, for the synonymy of the first two, and Kofoid, 1907, for that of *C. ostenfeldi*).

Evidences of Genuineness and Completeness.

The internal evidence is conclusive that this is a genuine chain and not a chance union. The connection is in every way typical. On the other hand, it is not certain that the whole of the chain is here represented. The relatively short apical horn of the anterior member is indicative alike of the recent formation of the chain and of this part of the skeleton; that is, it is not A_1 but A_{1+x}. A comparison of this chain with the one previously discussed and that of *C. vultur*, shown in plate **4**, fig. 7, will tend to confirm this conclusion. Again, it is also uncertain whether or not the posterior member of the original chain is here represented by the rear cell. I can find no internal evidence that is absolutely conclusive in either direction. The chain may therefore be comparable with $\frac{\mathrm{III}_3}{\mathrm{IV}_3}$ or with $\frac{\mathrm{II}_3}{\mathrm{III}_3}$ of the chain shown on plates **1–3**, or in more general terms with $\frac{(\mathrm{I}+x)_y}{(\mathrm{II}+x)_y}$, in which x represents the number of these individuals in the chain beyond the first, and y the number of the generation to which they belong. It is, however, to my mind more probable that the pair was not terminal $\left(\frac{\mathrm{III}_3}{\mathrm{IV}_3}\right)$ but intermediate $\left(\frac{\mathrm{II}_3}{\mathrm{III}_2}\right)$ in position, in such a relation as exists in the case of $\frac{\mathrm{II}_3}{\mathrm{III}_3}$ in the chain on plates **1–3**; that is, the present cells were not separated in the last schizogony, and consequently the anterior skeletal moiety of the foremost cell and the posterior of the rear one were not joined in the skeleton of any parent cell. They are not sister cells, but cousins of indeterminate degree of nearness or remoteness. The grounds upon which this conjecture rests are: (1) the forward cell is 20 per cent wider at the girdle than the rearward one; (2) the lengths of the sides of the plates along the fission lines differ so in the two cells that they cannot be joined without considerable change in their length.[1] We are therefore left in doubt, and perhaps in total ignorance, of the form of the ancestral skeleton. We can only say with certainty that these two very diverse cells, these two species of Ceratium, have descended from an ancestral cell similar to one of the two or possibly totally different from either. In view of the limited number of cells usually found in Ceratium chains, the short time in which chain formation, as a rule, continues and the youth (relative shortness of the apical horns) of both cells, the inference may be made that generations which separate them from the ancestral form are few rather than many, and that the relationship between the two cells is near rather than remote.

In the case of the mutation of *C. tripos* to *C. californiense* there was evidence in the chain (plates **1–3**) that the change was to a slight degree graduated, that is, that the second division produced a more pronounced type of *C. californiense* than the first. In the case of *C. ostenfeldi* and *C. californiense* the chain is too short to yield any evidence. I have found, however, in the plankton of the Pacific several individuals of *C. californiense* which exhibit structural features which tend toward but do not attain the characteristics of subgenus Macroceratium. For example, the following have been recorded : individuals with the lateral curvature of the antapical horns slightly more pronounced than in the normal individual, and again, with one or both antapical tips squarish (plate **4**, fig. 6), but still closed, and one case with one tip plainly open (autotomy?). These observations lead me to surmise that the phenomenon of abruptly transitional forms exists also here between the two types involved in this mutation. In the one mutation, and possibly in both, however, the changes, in comparison with the variations of the fluctuating type are: (1) less frequent in occurrence; (2) more extreme in their amplitude; and (3) involve at the same time a whole complex of fundamental characters.

EARLIER OBSERVATIONS ON MUTATIONS IN PROTISTA.

Mutations in Diatoms.

A phenomenon similar in some respects to the mutations in Ceratium has been found by Müller (1903, 1904, 1906) in the colonies of Melosira, a fresh-water diatom in which the cells are normally found joined together in linear filaments or chains. In the same filament Müller found cells with thick walls and coarse pores, and those with thin walls and fine pores in a different pattern of arrangement. In such chains cells were also found with the two valves different, one of them of the heavy, the other of the lighter type. The cells of the two types were, however, of the same form and size. He concluded in his first interpretation (1903, 1904) that he was dealing with instances of "Sprungweise Mutation." These mutations occurred in several species. Later (1906), following the publication of Gran's paper (1904) and Karsten's (1904) critique upon his own and Gran's interpretation, he changed his conclusion to accord with that of Gran, that is, that these were cases of polymorphism.

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[1] The fact that in the chain shown in plate **1** two sister cells, the third and the fourth, have apparently unequal transdiameters, is due to the obliquity of the position of III_3 when sketched. In plate **3** the real dimensions are better shown.

In the Arctic plankton Gran (1904) found *Rhizosolenia semispina*, a species with thin walls, long intermediate bands and slender pointed tips with a thin terminal bristle, a species abundant in spring and summer. Within its range of distribution occurs also *R. hebetata*, a winter species of about the same size, with thick walls, short intermediate bands, and blunt rounded tips. Chains are not found in these species, but Gran found single individuals in which one half of the skeleton was that of *R. hebetata* and the other that of *R. semispina*, indicating a sudden change from the former to the latter. A similar connection between two species was found by Gran in chains containing *Chaetoceras criophilum* and *C. boreale*, in which the former has suddenly given rise to the latter. It is, perhaps, significant that these mutating chains were taken "aus relativ warmen Wasser ausserhalb des nördlichen Norwegens," while the Rhizosolenia in which evidences of mutation were found occurred in "Planktonmaterial von der Grenze des Treibeises." These are both regions where environmental contrasts were strongly marked, where factors exist which might call forth mutations.

Gran's interpretation is best given in his own words : "Wenn um die Rhizosolenien als Beispiel zu nehmen — *R. hebetata* sich in *R. semispina* verwandeln kann, aber *R. semispina* niemals oder nur ausnahmsweise in *R. hebetata* übergeht, dann können wir von einer Mutation sprechen. Wenn aber die beiden Formen unter dem Einfluss von wechselnden äusseren Faktoren regelmässig ineinander übergehen können, dann haben wir eigentlich nur eine Art, und die Veränderungen sind Aeusserungen eines gesetzmässigen Dimorphismus." He adds thereto the idea that in the two species with practically similar areas of distribution *Rhizosolenia hebetata* is adapted to winter and Arctic conditions with slow reproduction, and *R. semispina* to those of spring and summer with more rapid multiplication and greater competition. He notes also the points of structure in which the winter form *R. hebetata* approaches a diatom resting spore, a phenomenon not without a parallel in the case of the Ceratium mutant *C. californiense*. But in neither case are the mutants typical resting spores.

In his critique Karsten (1904) concurs in Gran's interpretation, and adds thereto the suggestion that the polymorphism is an adaptation to flotation.

The correctness of Gran's interpretation rests fundamentally upon two hypotheses: (1) that mutations are not reversible, and (2) that such sudden changes in form called forth by environmental conditions cannot be regarded as mutations but must be regarded as dimorphism (polymorphism). Added thereto is the secondary question as to the numbers of the mutants of the organisms mutating. That is, does *Rhizosolenia hebetata* have its origin *solely* by mutation regularly each recurring season from *R. semispina?*

The process of mutation is undoubtedly reversible in some cases. Mutants of *Oenothera lamarckiana* have given rise in turn to the parent form (MacDougal, Vail, and Shull, 1907). Herpetomonas forms give rise to Trypanosoma forms and *vice versa.*

Mutants arise, in some cases at least, in response to known stimuli (Tower, 1906, MacDougal, Vail, and Shull, 1907), and it seems reasonable to believe that abrupt hydrographic changes in the environment of the plankton may serve as stimuli. The mutations found by Gran and those in Ceratium have occurred in regions or times of environmental contrasts. The number of instances of mutation, or the coefficient of mutability, has been proved to be variable (MacDougal, Vail, and Shull, 1907). There is apparently no necessity that it should always be low or remain at the same level. This coefficient is probably a function at a given time of the number of individuals in a physiological state in which stimuli producing mutation become effective. In the case of asexually produced functional individuals of the protists we may reasonably expect that the observed numbers of mutants would be larger, and possibly, also, that the coefficient would be higher, than in the sexually produced (Huxleyan) individuals of the Metazoa and Metaphyta. We may still correctly designate the process as mutation, though the numbers of mutants be large. On the other hand, should mutations be of necessity rare and Gran's objection to applying the term mutation to the phenomenon hold good, there is as yet no basis in observation for concluding, in so far as can be determined from Gran's data, that the actual changes of *Rhizosolenia hebetata* to *R. semispina* and *vice versa* are coincident in number and in extent of distribution with the phenomenon which he designates as a seasonal dimorphism of one species, *R. hebetata,* with a winter form, f. *hiemale,* which changes to a summer one, f. *semispina,* and *vice versa.*

With our present knowledge another interpretation is, I believe, certainly possible, namely, that *R. hebetata* and *R. semispina* are two distinct species with separate seasonal (predominant) distribution, and that under the stimulus of certain environmental factors they mutate with a coefficient at present unknown, the one to the other. The fact that the actual change (mutation) from Gran's winter form (*hebetata*) to the summer one (*semispina*) was observed by him in plankton taken in February in the middle of the Arctic winter does not particularly favor the seasonal dimorphism interpretation.

Mutations in Desmids.

Desmids eaten by Daphnia and Cypris continue to divide in the digestive tract. This has been observed by Cushman (1904) in the three genera Cosmarium, Euastrum, and Micrasterias. The newly forming semi-cells are, however, unlike the parent cell, being of bizarre and contorted form, possibly as a result of the stimulus of the secretions of the digestive tract.

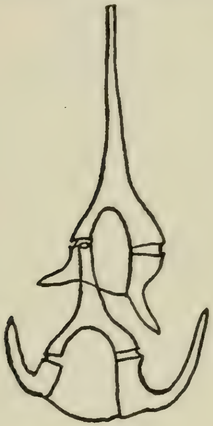
The occurrence in nature in the plankton of Loch Morar of desmids one semi-cell of which has the structure of *Xanthidium subhastiferum* and the other of its var. *murrayi* has been noted by W. and G. S. West (1903). This phenomenon is similar to that in diatoms and dinoflagellates and presumably originates in like fashion.

Mutations in Ciliates.

In pure cultures of *Paramecium caudatum* Calkins (1906) found among the daughter cells arising by the early divisions of an exconjugant a strain of *P. aurelia* which continued to exhibit the characters of this species, to wit, two micronuclei, and smaller size, for about three months through forty divisions, when the culture reverted to *P. caudatum.* Calkins is inclined to doubt the validity of a number of the characters previously used to separate the two species and is inclined to combine them as one. In my opinion the phenomenon with which he was dealing is similar in all important phases to that in Ceratium, and may be regarded as a process of mutation, occurring in the course of asexual reproduction and producing a weak species, *P. aurelia.*

Mutations in Ceratium.

Ceratium chains showing phenomena similar to those here described have been observed by Lohmann (1908) in the marine plankton at Kiel: "Bei Versuchen Plankton in grossen Glashäfen zu kultivieren fand ich bei der täglichen Untersuchung kleiner Wasserproben durch Zentrifugieren und Filtrieren zahlreiche Ketten von *Ceratium tripos*, die bisher in der Ostsee nicht gefunden waren. Später zeigte sich bei der Untersuchung der Netzfänge, dass in diesen keine einzige Kette zu finden war, während die Filterfänge solche enthielten. Es müssen also die Individuen einer Kette bei der Netzfiltration in der Ostsee sich von einander lösen, während sie im Nordsee-und Ozeanwasser so fest miteinander verbunden sind, dass sie auch in den Netzfängen erhalten bleiben. An diesen Ketten liess sich nun leicht der Nachweis führen, dass alle Jugendformen Hensens besondere Formen von *Ceratium tripos balticum* sind und in den Entwickelungsgang dieser einen Art gehören. Es besteht hier also ein ausserordentlich reicher Polymorphismus, der aber nur in ganz bestimmten Perioden des Jahreskreislaufes hervortritt und also unter den Begriff der Temporalvariationen fällt. Ausser den von Hensen beschriebenen Formen kommen noch


D.

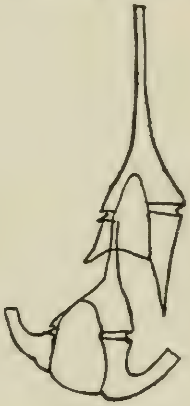

E.

Fig. D. Mutating chain of *Ceratium tripos balticum* after Lohmann (1908, p. 270, fig. 21, II a) "Temporalvariationen von *Ceratium tripos balticum* II. a. forma *lata*, Kette von forma *typica* und forma *lata*."

Fig. E. The same after Lohmann (fig. 21, III b). "Kette von forma *truncata* und *lineata*."

einige andere vor." The fact that chains were not found in the collections made at Kiel in the Baltic, but were found in the North Sea and Atlantic, is possibly due to the times of the day at which collections were made in the two regions.

Lohmann unfortunately gives us no clue to the relative abundance of the heteromorphic chains observed by him, but the inference one is led to make from his discussion and conclusion is that they were not uncommon, perhaps were numerous. He figures but two chains, and these only in outline sketches which are here reproduced in figures D (his figure 21, II a) and E (his figure 21, III b); the first represents a chain of two individuals, the posterior schizont being a normal *Ceratium tripos balticum* Schütt [1] and the anterior a Ceratium of different type called by Lohmann *C. tripos balticum* forma *lata.* This anterior member is similar in some particulars to the second cell (II_3) of the chain figured by me on plates **1–3** and also to the cell (I_2) of the previous generation which may be reconstructed from the skeletal parts A_1 and P_2, the homologue of the anterior cell in Lohmann's chain.[2]

Judging from the length of the apical horn, this chain is complete anteriorly, possibly also posteriorly, though the antapical horns of the posterior member of the chain are relatively short. In any event, whether the two cells are sister schizonts or not, they are of different types. The posterior is *C. tripos balticum*, belonging to the subgenus Tripoceratium, and the anterior is *C. minus*, belonging to the subgenus Biceratium, but still showing in the lateral deflection of its antapical horns a slight tendency toward the Tripoceratium type of skeleton.

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[1] Schütt (1893, p. 70) applies this name to both the Baltic and Atlantic forms of *C. tripos*, forms which Ostenfeld (1903) later separates as *C. tripos* var. *subsalsa* (Baltic form) and *C. tripos* var. *atlantica*, and Paulsen (1908) in his monograph of the Peridiniales in Nordische Plankton follows the usage of Ostenfeld.

[2] A young Ceratium with undeveloped apical horn and very short diverging antapicals which has many points of resemblance to Lohmann's f. *lata* was described as *Ceratium minus* by Gourret (1883) from Marseilles. Another Ceratium of somewhat similar form as regards the shape of the midbody, the shortness and direction of the antapical horns, was figured by Bergh (1881), from Baltic waters as a variety of *C. furca.* This form was designated later by Lemmermann (1899, p. 347) as *C. furca* var. *divergens.* Lemmermann included in this variety Bergh's figures 14–17, but figure 17 is *C. lineatum* Ehrbg., and only figures 14–16 should be assigned to a relationship to Lohmann's forma *lata.* The indications are that Bergh (1881), Gourret (1883), and Lohmann (1908) were all dealing with the same form and that Gourret's, the older name, should be used for it. There is also a possibility that *C. californiense* is the tropical representative of this northern form. A more extensive study of both northern and southern forms is needed for a final settlement of the question.

The second chain figured by Lohmann (fig. E) consists also of two individuals. The rear cell is designated by him as *C. tripos balticum* forma *truncata,* and the forward cell as *C. tripos balticum* forma *lineata.* As I have elsewhere (Kofoid, 1908) shown, autotomy is of wide occurrence in the genus Ceratium. It is a degeneration phenomenon taking place in adverse conditions which, in plankton sinking to deeper and colder waters, is correlated with flotation and assumes an adaptive significance. The posterior member is an autotomized individual of *C. tripos balticum.* The anterior member resembles the species described by Ehrenberg from the northern waters as *C. lineatum* and appearing often in the literature of recent years as *C. furca balticum* Moebius, a spurious name, for Moebius never described such a species.

Lohmann's forma *lineata* as seen in the anterior cell (heteromorph) of his figure III b has certain structural features in which it resembles his f. *lata ;* such as the form and proportions of the midbody, the shape of the ventral plate, the divergence of the right horn, and the dimensions of the cell. It differs in its tapering posteriorly directed left antapical horn. This difference may be partially accounted for by the seeming obliquity of the view shown in Lohmann's figure III b. In it the left side of both cells is relatively expanded and the right foreshortened, and the left horn may be so placed that any divergence is obscured by the angle of vision. A close relationship between the heteromorphs of the two chains figured by Lohmann is, in the light of these considerations, not improbable.

The cells of this chain are representatives of the two subgenera Tripoceratium and Biceratium. By reason of the considerable length of the apical horn of the anterior schizont and the autotomy of the antapicals of the posterior one, the chain may be regarded as complete or entire, the result of a single schizogony, in which occurs a complete saltation from *C. tripos balticum* to a form resembling *C. lineatum*, with less apparent tendency to produce an intermediate condition such as is manifested in the other chain Lohmann figures (fig. D) or in that shown in plates **1–3**.

SIGNIFICANCE OF THE PHENOMENON.

The fact of supreme importance in the phenomena recorded by Lohmann (1908) and observed by myself in greater diversity, is the abrupt and complete change in form in a line of descent in a single, or at the most in two generations of organisms asexually reproduced. The change is recorded in immovable skeletal parts which reveal with unmistakable clearness the transmutation in form while the accessory phenomenon of chain formation renders possible a rigorous certainty in determining the line of descent. These changes give rise, not to new types, hitherto unknown, but old well-known types give rise suddenly to others old and well known or at least previously known. The particular category to which these types are referred, species, subspecies, varieties, or forms, is a subordinate matter. For convenience in discussion and also as an expression of my own opinion I have regarded them in the preceding pages as species and shall continue to do so in those that follow. The importance of the change in form is, however, not removed by a change in the category to which they are assigned. The fact here remains that like gives rise to unlike, that the descendents differ profoundly from the ancestral type.

Unknown Factors.

What, then, is the biological significance of these abrupt changes? No conclusive answer at present can be given to the question, for there are so many deficiencies in our knowledge of dinoflagellates in general, of the conditions of life in the sea, and of the prevalent causes and consequences of these phenomena of sudden change, that all conclusions must contain a large element of uncertainty owing to this relatively narrow basis of fact. For example, we know as yet nothing of sexual reproduction in the marine dinoflagellates beyond the occurrence of resting spores that possibly have a sexual origin. Are special gametes formed, or are all schizonts capable of conjugation? We have as yet no adequate quantitative studies of the extent and character of variation in the species of the genus nor correlation of these changes with the physical factors of the environment such as the temperature, salinity, and molecular friction. Ostwald's (1903) theoretical formulas regarding specific surface and molecular friction are yet to be put to the test of a practical application in Ceratium. Are species with different specific surfaces and individuals within the species having different surfaces distributed in the sea at such seasons and in such places as to conform to Ostwald's computations? Will Entz's (1905) conjectures as to the existence of universal intergradations of species in the genus Ceratium bear the test of an intensive study by the statistical method? Will Lohmann's (1908) suggestion of a widespread seasonal polymorphism in the genus find confirmation in pedigree cultures?

Beyond the instances here recorded we know nothing of the extent to which these changes occur in nature, nothing of their seasonal and geographical distribution. Do they occur in all seas and at all seasons, or only at certain times of the year or of the life cycle of the organisms, or only in certain localities or under certain conditions? Are other species in the genus also produced in the same way? Are certain rare and aberrant species produced in this way? For example, are *Ceratium reflexum* and *C. paradoxides*, which are always found singly, and seem to be structurally ill-adapted to flotation and unable because of their defects ever to establish themselves, — are these defective species continually produced and maintained by repeated mutations? In what proportion of schizogonies do these sudden changes occur? What would a complete genealogy of all the descendants from one pair of gametes of Ceratium reveal as to constancy in form?

Again we have no conclusive evidence as to the factors which cause or bring about these sudden changes. Are they due to internal phenomena proper to the cell itself, to abrupt changes in ratio of nucleus and cytoplasm, or in the morphology and functional activity of the chromatin substance, to heterotypical rather than typical mitoses? Or are they due to the shock of modification in external factors such as changes in temperature, salinity, or the chemical composition of the sea water, or to the interaction between these external forces and the substances and processes of the cell?

The consequences of these sudden changes in form are also wholly unknown. There is as yet no evidence as to the fate of the newly formed mutants. Do they continue to produce their own kind by schizogony? Do these schizonts conjugate, and are the descendants of the resulting zygote similar to the gametes or to their heteromorphic ancestor? Do they revert to ancestral types, remain constant, or possibly form other and different species of Ceratium? Is there a normal, usual cycle of changes or are such changes sporadic and exceptional?

Could an answer be given to any of these queries, much light would be shed upon the meaning of this phenomenon, its relation to life processes of the organism, and its significance for the theories as to the origin of species and the process of evolution in general.

Four different interpretations may be given to the phenomenon.

Seasonal Polymorphism (*Gran and Lohmann*).

These changes are seasonal, temporal variations. This is the interpretation of Lohmann (1908), who has followed in the main the conclusions of Gran (1904) regarding a similar phenomenon in diatoms. He regards the heteromorphic schizonts, the anterior members of his chain (see figs.

D and E) as summer forms of *C. tripos balticum*, the one (fig. D) as forma *lata* and the other as forma *lineata*. He subsequently introduces the second or gamete hypothesis, which will be discussed later, but favors the first interpretation, however, for he revises the nomenclature of these species of Ceratium, and throughout his paper refers to *Ceratium* "*lineatum*" (anterior schizont in fig. E) as *C. tripos balticum* forma *lineatum* and to *C. minus* Gourret (anterior schizont in fig. D) as *C. tripos baltica* forma *lata* f. nov. From the discussion and treatment of these forms in his tables he evidently regards all *C. lineatum* and *C. minus* which were found in his plankton collections from the Baltic as well as those found in heteromorphic chains as summer forms of *C. tripos* var. *balticum*, and gives figures of a number of isolated individuals of typical *C. lineatum* Ehrbg., which he also designates as such forms of *C. tripos.*

It is difficult, with merely the outline figures of Lohmann to examine, to pass critical judgment upon the specific identity of the forms he figures. Certain differences, however, between the anterior heteromorphic schizont of his chain (III b) (fig. E) and the typical *C. lineatum* shown in his figures III c, d, f, and g of detached schizonts lead me to doubt the specific identity and genetic continuity of the two forms. (His figure IV g is reversed ; that is, it represents the dorsal side seen from the ventral face.) *Ceratium lineatum* has a midbody of different proportions from the heteromorph. The following table of proportionate measurements, using the transdiameter of the individual as the unit of measurement, expresses these differences :

		Ceratium lineatum, Lohmann's figures III c, d, f, g, extremes and averages.	
	Heteromorph.	Extremes.	Averages.
Length of midbody	1.4	(1.6–1.9)	1.75
Distance from girdle to . . . . . Postmargin in axial region	.5	(.60–.65)	.63
Length of left antapical	.82	(.75–1.2)	1.0
Length of right antapical	.43	(.43–70)	.62
Transdiameter of figure in millimeters .	11.	(7.5–9.)	8.1
Ratio of two horns	1:1.9	1:1.6	

The midbody of *C. lineatum* is absolutely smaller, relatively narrower and longer, and tapers more gradually into the apical horn. Its two antapical horns are not so unequal in length. Lohmann states that the volume of the smallest individuals of f. *lineatum* is only one tenth of that of *C. tripos balticum*. The possibility of a confusion here by Lohmann of *C. lineatum* and Ehrenberg's minute species *C. eugrammum*, of similar habitus but smaller size, is not wholly excluded. The chain of two individuals of forma *lineata* (Lohmann, fig. III c) resembles the heteromorph in the more rotund midbody and has its proportions, though of smaller size. While the possibility of a complete transition from the heteromorph cell (fig. E) to *C. lineatum* is certainly open, it hardly seems to me that Lohmann's published data are adequate to establish this derivation or the conclusion that *C. lineatum* of Baltic summer plankton owes its origin to heteromorphic divisions of *C. tripos.*

Included in Lohmann's figures of *C. tripos balticum* f. *lata* are two isolated individuals (II c and d) which have the rotund midbody of the other figures of f. *lata* and also of the heteromorph of his figure III b. They have, however, a different facies. They are smaller than f. *lata*, have a greater disproportion in the antapical horns, and the apical horn is short, displaced to the right, and its axis is oblique to that of the midbody. I have never seen this species with a long apical horn. This is *Ceratium ehrenbergi*, described by me (1907) from the Eastern Tropical Pacific, where it is widely distributed though relatively rare. It does not there intergrade with any Ceratium similar to Lohmann's f. *lata* (= *Ceratium minus* Gourret).

In addition to the internal evidence in Lohmann's figures for holding in abeyance his interpretation of these heteromorphic schizonts as seasonal forms of *C. tripos*, there are certain other considerations which weigh against this conclusion.

(1) The changes between *C. tripos balticum* and the heteromorphs in Lohmann's chains and those observable in the chains found by me are not of the type to be expected in seasonal variations in *C. tripos* and in the subgenus Tripoceratium. In general, in warm seas long-horned species of Ceratium, occur and in colder water the shorter-horned ones (see Schütt, 1898, Chun, 1905, and Karsten, 1907). My own observations on the plankton of the Pacific at San Diego and in the collections of the "Albatross" confirm this, and also show that the same species grow longer horns in warmer than in colder waters at the same or in different localities. Minkiewitsch (1900) and Entz (1905) have noted a similar difference in Ceratium in the Black and Adriatic seas between such summer and winter forms. Changes are brought about by mere lengthening of the horns. Usually all three share proportionally in the process, though there are some species in which the apical horn is the one most modified. Beyond this lengthening and some attendant changes in the calibre and flexibility of the horns and in some cases changes in size, which may or may not be a part of this adaptive process, these seasonal

(temperature) variations leave the general facies or habitus of the organism unchanged, and are not of the abrupt type seen in these heteromorphic chains where the whole form of the organism is suddenly recast in another entirely distinct mould or pattern. These seasonal changes belong rather to the fluctuating type of variations, while those of the heteromorphic chains are saltatory in character.

The physical conditions prevalent at the time of the greatest increase (September 7–28) in numbers of these smaller individuals (see Lohmann's table, p. 242–243) give a constant index of molecular friction (64.5 to 65). It is also a period of falling temperatures. Lohmann's conclusions and tables require that in the face of this *C. tripos balticum* should give rise (on September 28) to 53.5 short-horned individuals to 100 of the type, individuals moreover of much smaller size and therefore of greatly increased specific surface. The volumes of *C. tripos balticum*, its f. *lineata* and f. *lata* are given in Tabelle B (Lohmann) as 100,000, 8,000, and 10,000 cubic micromillimeters respectively. (The volumes of the two forms are stated on p. 271 to be 1/8 and 1/10, respectively, of that of the type.) This means at least a doubling of the specific surface of the organism in the "seasonal change." With constant molecular friction and *falling* temperature it seems incredible that *Ceratium tripos* should suddenly give rise to considerable numbers of smaller forms, "seasonal variations," in which the specific surface of the organism is doubled, an adaptation to *rising* temperature and falling molecular friction! This is an additional reason for believing that these *smaller* forms do not lie in the genetic cycle of *C. tripos balticum*, but are independent species included incorrectly in Lohmann's tables, and that their sudden increase in the plankton of Kiel was due to other causes than seasonal variation of *C. tripos.*

(2) The known distribution of *Ceratium lineatum* (*sensu latu*), *C. californiense*, and *C. minus* affords no satisfactory basis for regarding them elsewhere as seasonal forms of *C. tripos.* The former species (*sensu latu*) (Cleve, 1900, 1902) has a wide range of distribution in colder and warmer seas, as has also *C. tripos* (*sensu latu*). In the seasonal and geographical distribution of *C. lineatum* (*sensu latu*) and *C. minus* and forms resembling it in the Pacific Ocean, I have found no indications which suggest that the two form a part of the genetic cycle of *Ceratium tripos* with seasonal limitations.

(3) The numerical proportions of *Ceratium tripos balticum* and the f. *lineata* (Ehrbg.) Lohmann and *lata* Lohmann are hardly those that would be expected if the latter are seasonal forms of the first. We would

expect in typical seasonal changes in Ceratium that a larger proportion of the individuals would be affected by the general climatic factors which underlie such modifications. As the following table, taken from Lohmann's paper, shows, the total numbers of all the short-horned "forms" constitute but a small portion of the numbers of the type *C. tripos balticum*, not exceeding 1 per 100 in 7 of the 15 collections between August 24 and November 29 and rising above 12 in but one instance, while only between September 21 and October 4 do the totals of the "forms" rise above one eighth of the numbers of the typical *C. tripos balticum.*

Their increase in numbers is (see table) preceded and accompanied by considerable fluctuations in the temperature, salinity, and specific gravity of the sea water. The conditions on August 24 represent the cessation of a rapid fall in temperature, 3° in a fortnight, increase in salinity (1.415 to 1.669), and specific gravity (9.26 to 11.79), with a less rapid increase in deeper (15 m.) waters (1.936 to 2.043). During the period August 24 to September 28 surface waters cool slowly to 13.9°, but deeper waters rise to 15.4° on August 31 and fall slowly during the following month. These changes are possibly the result of the Baltic circulation, and in comparison with other conditions at other seasons in the table are unusual. Change is indicated in the character of the water. Lohmann's tables therefore exhibit to an unknown extent the effect of this circulation, and the changes in numbers of the organisms under discussion may in part (how large can only be conjectured) be due to the inflow of water of higher salinity and a different plankton content. A hydrographic factor introducing a different plankton rather than merely a seasonal one modifying an existing plankton is suggested by these physical data as operative in producing the changes shown in the relative numbers of the organisms listed in Lohmann's statistical tables.

The same hydrographic causes probably underlie the occurrence in the winter plankton of the Baltic of *Ceratium tripos balticum* forma *pendula* and f. *penduloides* Lohmann (= *C. tripos* f. *hiemale* Paulsen). This is a long-horned *C. tripos*, probably entering the Baltic in winter, as Lohmann suggests, with the invasion of waters of higher salinity (Gulf Stream ?). Though it has a seasonal occurrence in the Baltic, it is probably not everywhere a "seasonal" form, as Paulsen's name and Lohmann's discussion seem to indicate, but an invader from warmer seas, where it is not uncommon. In Baltic waters abnormal conditions (see Lohmann's figure 21 I g, h) arise in the horns as the result of the changes to which it is subjected as the invading waters mingle with those of lower salinity.

MEMBERS[1] OF CERATIUM TRIPOS BALTICUM AND CHANGES IN ENVIRONMENTAL FACTORS.

(Compiled from LOHMANN, 1908, p. 276, and Table A.)

Dates of Collection.	August, 1905.		September.			
	24.	31.	7.	14.	21.	28.
Typical C. tripos balticum . . .	680,000	240,000	200,000	185,000	280,000	160,000
Total short-horned forms . . .	170	580	1,990	13,900	33,000	85,800
(*a*) f. lata	170	. . . .	180	5,600	30,000	66,000
(*b*) f. truncata	. . . .	120	310	3,600	1,700	16,000
(*c*) f. lineata	. . . .	460	1,500	4,700	1,300	3,800
(*d*) To 100 of the type . . .	0.02	0.2	1.0	7.5	12.0	53.5
Molecular friction after Ostwald	68.	64.	64.5	65.	65.	65.
Temperature (C.°) at surface .	15.9	15.8	15.8	15.	14.4	13.9
Temperature (C.°) at 15 m. . .	13.0	15.4	15.2	14.4	14.2	14.4
Salinity (%) of the water, 0 m.	1.669	1.604	1.472	1.526	1.546	1.640
Salinity (%) of the water, 15 m.	2.043	1.730	1.655	1.795	1.748	1.748
Specific gravity of the water, 0 m.	11.79	11.32	10.32	10.84	11.84	11.66
Specific gravity of the water, 15 m.	15.19	12.44	11.82	13.04	12.71	12.68

October.				November.				
4.	12.	19.	26.	1.	8.	17.	24.	29.
180,000	44,000	110,000	110,000	590,000	250,000	55,000	44,000	47,000
21,900	2,810	4,620	420	8,900	2,170	310	413	....
14,000	1,800	420	130	1,100	270	140	....	....
2,600	250	1,700	90	400	600	....	83	....
5,300	760	2,500	200	7,400	1,300	170	330	....
12.0	6.5	4.0	0.4	1.5	0.8	0.5	0.9	....
66.5	71.5	75.	80.	78.	77.	84.5	84.	84.5
12.0	10.7	9.2	7.6	7.7	7.4	5.7	4.6	5.0
....	11.2	9.6	7.4	8.4	8.5	5.5	5.7	5.5
1.530	1.498	1.499	1.505	1.499	1.487	1.490	1.429	1.438
1.781	1.572	1.523	1.512	1.617	1.617	1.517	1.483	1.449
11.40	11.38	11.54	11.73	11.69	11.66	11.83	11.41	11.42
13.09	11.82	11.67	11.82	12.54	12.52	12.05	11.78	11.51

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[1] Per 100 meters.

We conclude, then, from an examination of Lohmann's hypothesis of seasonal forms, that the heteromorphs are not of the character to be expected in seasonal changes, that the evidence of any genetic connection between them and the *C. lineatum* and *C. ehrenbergi* of his figures is inconclusive, and that his tables of seasonal distribution of his seasonal forms probably include other species than the heteromorphs and in part illustrate the changing population due to circulation of the Baltic.

Gamete Hypothesis.

As a corollary to the first hypothesis of seasonal variation, Lohmann proposes a second, to wit, that the two forms, f. *lata* and f. *lineata*, are stages of *C. tripos* which conjugate; that is, they are gametes. The reduction in size which he believes occurs in the descendants of the heteromorphs of the chains he regards as an adaptation to greater ease of movement on the part of the gametes facilitating conjugation. He calls attention to the occurrence of these so-called gametes immediately after the culmination of the greatest numbers of *C. tripos balticum*, a period when gametes and sexual reproduction would naturally be expected.

While not accepting his interpretation that all f. *lata* and f. *lineata* in his figures and tables are heteromorphs or their derivatives, I believe that the hypothesis that the heteromorphs themselves and their derivative may be gametes must certainly be held open until the actual process of sexual reproduction in some marine species of Ceratium is known. But certain considerations militate against this hypothesis.

(1) Lohmann lays emphasis upon the reduction in size which he finds in his seasonal forms. The isolated individuals of *C. tripos balticum* f. *lineata* are (fide Lohmann) but one tenth and f. *lata* but one eighth of the volume of *C. tripos balticum*. The heteromorphs in his chains (fig. II a and III b) show no such reduction in size. I have given above my reasons for doubting the conclusion that all of the isolated individuals showing this reduction belong in the cycle initiated by heteromorphs. I deem it probable that *C. lineatum*, *C. eugrammum*, and *C. ehrenbergi* have been included by Lohmann and are the cause of a part, at least, of the seeming reduction he has found. Decrease in volume, other things being equal, results in increased specific surface, and is, it seems, an adaptation to higher temperatures and decreased molecular friction in the sea water, and may therefore facilitate locomotion. My contention is only that Lohmann's evidence is inconclusive that the smaller individuals which exhibit this "reduction" lie in the

same genetic cycle with the larger *C. tripos* and are therefore to be regarded as gametes of that species.

(2) Both *C. tripos* and *C. ostenfeldi* (plate 1 and plate 4, fig. 4) have been found by me in chain with the same type of heteromorph. There is, as I have shown (p. 228), some difficulty in determining what the ancestral cell was in the heteromorphic chain containing *C. ostenfeldi* and *C. californiense.* In any event it seems improbable that we should find the same type of skeleton-bearing gamete for the two species *C. tripos* and *C. ostenfeldi*, or that *C. californiense*, being a gamete of *C. tripos*, should give rise to *C. ostenfeldi* by schizogony. Any interpretation of this chain in accord with the gamete theory is, with our present knowledge, beset with difficulties.

(3) The known cases of conjugation in Ceratium do not lend support to the view that special gametes marked by a sudden change in form from the parent type are produced prior to conjugation. Zederbauer's (1904) and Entz's (1907) description of conjugation in *C. hirundinella,* a fresh water species, shows the union of normal forms of that species. Pouchet (1885) figures two cases of the union of two individuals of *C. fusus* in ventral apposition with extruded (?) plasma in one case, and another instance of conjugation (?) of *C. biceps* has come under my observation. In all three instances presumably of conjugation, the gametes are *normal* individuals of the species.

If these heteromorphs are neither seasonal forms nor gametes, what is their biological significance? I have two alternative hypotheses to make, both provisional in view of our imperfect knowledge of the process and its results with which we are dealing, hypotheses, moreover, which are perhaps not mutually exclusive but merely two aspects of, or methods of approach to, a common phenomenon.

Degeneration or Atavism Hypothesis.

The heteromorphs are degenerate or atavistic forms of dominant thriving species called forth by the impact of new and perhaps adverse conditions to which they are subjected by the circulation of the sea or their own active or passive movements principally in the vertical direction. The exceedingly great sensitiveness of pelagic organisms to even slight changes in their environment is quickly impressed upon one who works with living plankton or traces their vertical and horizontal distribution. For example, certain species of dinoflagellates rarely appear in the plankton taken near shore at San Diego or Naples, but only at a distance of several kilometers. A similar phenomenon appears also in the vertical distribution of certain species. Yet the differences in the environing factors attending these changes in distribution may be very slight. The pelagic fauna is attuned to environmental changes of smaller amplitude than that to which the shore and land fauna are subjected, and presumably is in turn profoundly affected by changes in these factors of an amplitude which has little or no influence upon organisms of a fauna with more varied environment.

My grounds for proposing this interpretation are twofold: —

1. The occurrence of degeneration forms in flagellates under culture in media different from their normal habitat. Küster (1908) finds that *Gymnodinium fucorum* when cultivated in 1–2 per cent salt solution or in sugar solutions gives rise to heteromorphic cysts of irregular forms which may be designated as degeneration stages, in the narrow sense of the word, since the forms are irregular and of various shape and the cultures often die out. Amœboid forms arise in agar and in gelatine cultures. Zumstein (1900) was able to cultivate *Euglena gracilis* on solid media and produce a heteromorphosis to Palmella-like groups of organisms.

The most striking instances, however, of heteromorphic changes are those called forth in Trypanosoma under culture in blood agar. A summary from the biological point of view of the recent results of work in this line will be found in Doflein (1909). Trypanosoma in such cultures takes on the form of Herpetomonas, an intestinal parasite of Diptera, a transformation which involves a considerable change in the position and relations of the flagella. The process is, moreover, reversible, for the Herpetomonas forms reintroduced into the blood are changed again to Trypanosoma. The heteromorphoses here induced by the modified environment are significant of the probable path of evolution of the parasitic Trypanosoma and might be regarded as an atavistic reversion. These reversions and the degeneration of Trypanosoma arising in other cultures may be regarded as stages in the operation of the same heteromorphic process in which the organism takes on another, and perhaps in some instances an ancestral, type of structure.

The heteromorphic chains of Ceratium may then represent a similar biological process. There is in *C. californiense* and in the heteromorphs figured by Lohmann a reduction in the extent of the horns. The parent cell in some cases also undergoes autotomy which may be likewise regarded as a degeneration phenomenon arising, as I have elsewhere suggested (1908), in response to the change involved in the sinking of the organism to deeper, colder waters. The heteromorphs possibly represent the first steps in a process whose last stages, judging from conditions in other organisms, would unquestionably be called degeneration. There is also a probability that the short-horned heteromorphs approach the ancestral type in form, for the species of the subgenus Biceratium are unquestionably more like the other genera of the Peridinidae, for example, like Peridinium and Gonyaulax, than are the long-horned species of Macroceratium and Tripoceratium. *Ceratium minus* or *C. californiense* affords a plausible starting point for the derivation of the other species of the genus, and their occurrence in heteromorphic chains might well be regarded as an atavistic reversion.

2. Another reason for suggesting that the production of heteromorphs is a degeneration phenomenon lies in the peculiarly hyaline character of the skeleton of *C. californiense.* It resembles in this respect to some extent the wall of what are probably the cysts of dinoflagellates for which Pouchet (1894) established the genus Sphaerosperma. There are other species in the genus, notably *C. teres* and possibly *C. inclinatum* and *C. tenuissimum*, all of which are relatively small forms, and have to some degree this peculiar hyaline aspect. Sutures are still present in these species, but are often exceedingly difficult to detect. Cysts of dinoflagellates have, in so far as they are known, no sutures and are peculiarly hyaline. I have often noted cyst formation (gelatinous or pellicular) in moribund dinoflagellates, and Küster (1908) finds it in his degenerating cultures of Gymnodinium. This resemblance to cysts on the part of the heteromorph, *C. californiense*, may be interpreted as an indication of degenerative phenomena, while its appearance in the other species named raises an interesting question as to their possible origin by a process like that which gives rise to *C. californiense*, involving, perhaps, certain other dominant and larger species of Ceratium which they more or less resemble.

Mutation Hypothesis.

The heteromorphs are mutants, the result of the process of mutation occurring in nature. The considerations which support this view are as follows: —

1. The change is saltatory. It is accomplished in a single schizogony or generation or at the most in two. It is not a process of the slow accumulation of minute variations or a gradual decline in structural characters. In the suddenness of its appearance and the completeness of the transformation the result in Ceratium is comparable with that obtained by DeVries (1905) in Oenothera, Tower (1906) in Leptinotarsa, and Calkins (1906) in Paramecium.

2. The instances of its occurrence appear to be rare. This is true in general of the elementary species mutating from *Oenothera lamarckiana.* With the single exception of an outbreak of *Leptinotarsa pallida* (in the field) the numbers of heteromorphic individuals obtained in the pedigree studies of Tower (1906) were small. The mutation of *Paramecium caudatum* to *P. aurelia* was observed but once by Calkins (1906) in his many cultures of this protozoan.

It is obviously no necessary criterion of a mutant that it should be rare. It is conceivable, indeed quite probable, that under certain suitable conditions in nature mutations might be called forth in great numbers at one time. The fact is merely stated that mutations have been seen in but relatively few instances among many of normal reproduction observed in Ceratium, and that this coincides with observations on mutation elsewhere. In this connection it is well to note that in view of the relative simplicity of their structural features, rapidity of reproductive processes, and the ease under favorable conditions with which great numbers of individuals can be assembled and examined, the Protozoa present unique opportunities for attack upon the problem of mutation. It is possible, for example, in a few days to pass in critical review more Ceratium than fishes, birds, or mammals in a lifetime.

3. The instances of its occurrence suggest the action of environmental factors in producing the mutations. In one at least of Lohmann's instances and in one of my own the parent cell had undergone autotomy. The distribution of autotomized Ceratium in the plankton of the sea suggests, as I have elsewhere (1908) shown, the action of environmental changes, possibly those resulting from the sinking of the organism or the vertical circulation of the water. Autotomized individuals of *C. tripos balticum* (forma *truncata* Lohmann) were rather common in the Baltic plankton at the time when the heteromorphic chains were found by Lohmann in aquaria stocked from the Baltic. As I have elsewhere noted, Lohmann's seasonal tables of physical data indicate a considerable change in the Baltic in temperature and salinity, suggestive of an unusual amount of circulation prior to and during the time when the heteromorphic chains appeared. Chains, however, were found only in aquaria where naturally the conditions as to illumination, movement of the water, and extent and character of temperature changes differ from those in the sea. It is possible that some of these changes were potent in stimulating Ceratium to mutation here.

The two cases of mutation found by me occurred about 1500 miles apart in the eastern tropical Pacific, but both in localities with certain hydrographic factors in common. They were both taken in regions where hydrographic contrasts were noticeable.

The heteromorphic chain shown in plates **1–3** was taken at Station 4737, 500 miles N. E. of Manga Reva in the southern margin of the great eddy that lies in the angle between the South Equatorial and the Humboldt current. The station was located over the depression between the Albatross Plateau and that from which the Paumotu Archipelago rises, a depression blocked to an unknown extent to the south by Pitcairn and other scattered islets. (See Mr. Agassiz's (1906) Report of the Expedition, plates 1 and 2.) Across this gap as the "Albatross" approached Manga Reva there was a rapid decline in surface temperatures from 81.5° to 77.5°. The distribution of surface temperatures elsewhere in this region suggests the existence (see Agassiz, 1906, plate 3 a) of a belt extending eastward from Manga Reva and skirting the southern edge of the Albatross Plateau in which there is a change in surface temperature, 4.5° in 4° of latitude, which is relatively rapid as compared with those in the region of the adjacent eddy. An area of higher specific gravity (1.0260 as compared with 1.0252–1.0256. See Agassiz, 1906, plate 3 b) extends in a similar direction. The specific gravity of the water at this station is higher than that upon either side for some distance. Temperature sections at adjacent stations (see Agassiz, 1906, plate 5) to a depth of 800 fathoms show noticeable irregularities but no extreme conditions. An unusually large amount of dead and moribund material (see Agassiz, 1906, p. 18) occurred in the plankton of this locality. The possibility of an upwelling from deeper layers in the neighborhood is thus suggested in view of the configuration of the bottom and the hydrographic conditions above noted. We may conclude that this heteromorphic chain occurred in a region offering possibilities of environmental contrasts.

The second heteromorphic chain (plate **4**, fig. 4) was taken at Station 4711, about 500 miles S. W. of Chatham Island and near the outer edge of the great Humboldt Current as it turns westward in the South Equatorial. The temperature conditions at this and an adjacent Station, 4713, were extraordinary (see Agassiz, 1906, p. 21, plate 8) in the rapidity with which the water became colder within the short distance of 50 fathoms from the surface. The temperatures at this station at the surface, 25, 50, 100, 200, 300, 400, 600, and 800 fathoms, were 75.3°, 73.8°, 59.5°, 54.9°, 51.1°, 45.6°, 43.4°, 39.2°, and 37.4°, a decrease in the first 50 fathoms of 15.8°, and in 100 fathoms of 20.4.° The change is most rapid between 25 and 50 fathoms, where it amounts to a difference of 13.3° in 25 fathoms. This is without exception the most rapid change in temperature recorded at any of the twenty-seven stations at which serial temperatures were taken on the expedition. It occurs, moreover, within the strata of water which normally is abundantly inhabited by Ceratium, and in amplitude it corresponds to changes in surface temperatures to be found only within 30 or 40 degrees of latitude.

The contrast in specific gravity of surface waters at this station (1.0256) and that (1.0252) of the adjacent one (4712) farther in the Humboldt Current is also extreme, though similar to the change found elsewhere along the western and southwestern edge of the current.

No less striking than the rapidity in change in temperature and density is the character of the plankton in this region (see Agassiz, 1906, p. 18). There was an unusual proportion of dead and moribund material, and the debris of plankton organisms, skeletons of dinoflagellates, diatoms, radiolarians, and fragments of copepods. The explanation of this rise of the isothermobath of 60° on the western margin of the current (see Agassiz, 1906, plate 8) and the accompanying moribund nature of much of the plankton is possibly to be sought in some phase of vertical circulation within the strata affected by the currents, such as an aspiration zone or an upward compensation movement at the edge of the current due to the piling up of water on its left margin as a result of the earth's rotation (see Nathanson, 1906, 1906 a), or to an upward suction between local diverging branches of the current (see Schott, 1903).

The location of this station with reference to the current and to the distribution of temperatures in the vertical direction is thus unique in the extremes of the environmental conditions afforded within relatively narrow limits in the zone inhabited by the phytoplankton.

That the shock of environmental changes upon the organism at the time of reproduction is potent in producing changes in form or mutations has been shown experimentally by Tower (1906) for Leptinotarsa. The changes noted by Calkins (1906) for Paramecium followed the isolation of a conjugating pair of individuals which doubtless involved some environmental change. The experiments of MacDougal, Vail, and Shull (1907) upon Oenothera indicate the potency of external agencies in producing mutations in plants.

The occurrence of these heteromorphic chains in regions where they may have been subjected to unusual environmental conditions is, I believe, one consideration for regarding them as mutants called forth by the shock of environmental contrasts. The autotomy of the horns in certain instances of heteromorphic chains is perhaps indicative of adverse conditions, such as sinking to a zone of low temperature. The return of such an individual to the upper levels by the vertical movement of the water might afford the occasion for renewed growth and reproduction for cells in suitable physiological stages. The schizogony which ensues results at once in a mutation, and with the new generation the line of descent passes into a new or different stage of equilibrium.

These heteromorphic changes in Ceratium occur in the course of asexual reproduction. There is no evidence that the parent cell is a zygote or one of a recently conjugated pair of gametes. If the idea of the individual is conceived in the Huxleyan sense, these mutants and those of the diatoms belong in the same category as bud sports and are to be regarded as isolated apical cells which have abruptly assumed new or different specific characters. Will the next sexual reproduction in the line of descent be followed by a reversion to the old form? Certain studies on bud sports (see MacDougal, Vail, Shull, 1907) indicate the permanence of the change.

The occurrence of mutations in the asexually reproduced individuals of Ceratium bring additional confirmation to the idea that mutations are not necessarily dependent upon sexual reproduction for their appearance, but are a manifestation of a fundamental property of protoplasm of plants and animals alike, a property which is variously manifested in the mutations of sexually produced organisms, as in the elementary species of Oenothera, in the results of the hybridization including those which follow the Mendelian formulae, in those in which asexual reproduction occurs, as in bud sports and in these heteromorphs of Ceratium, and perhaps, also, in many types of neoplasms and abnormalities. They are a manifestation of unit systems (see Ritter, 1907) changing under stimulus in kaleidoscopic fashion from one stage of equilibrium to another.

The seeming reversion in these mutants of Ceratium to old and fundamental subgeneric types, the occasional reversibility of mutations elsewhere, and the limitations in the range and number of mutant types appearing generally in nature and under culture, suggest that the chemical nature of living substances and the ever fleeting organization of these substances in equilibriums of living structures which we call organisms, place certain rather definite restrictions upon the number and amplitude of the departures which mutants make from their sources. From the point of view of mutation the relation which exists among the members of a group of elementary species, or perhaps among the species of a genus, presents a striking analogy to that which has been found to exist among the various radio-active substances or members of a chemical series of related organic substances. Such a view tends to bring the organization of the living world into closer agreement with the organization of matter as it is seen elsewhere.

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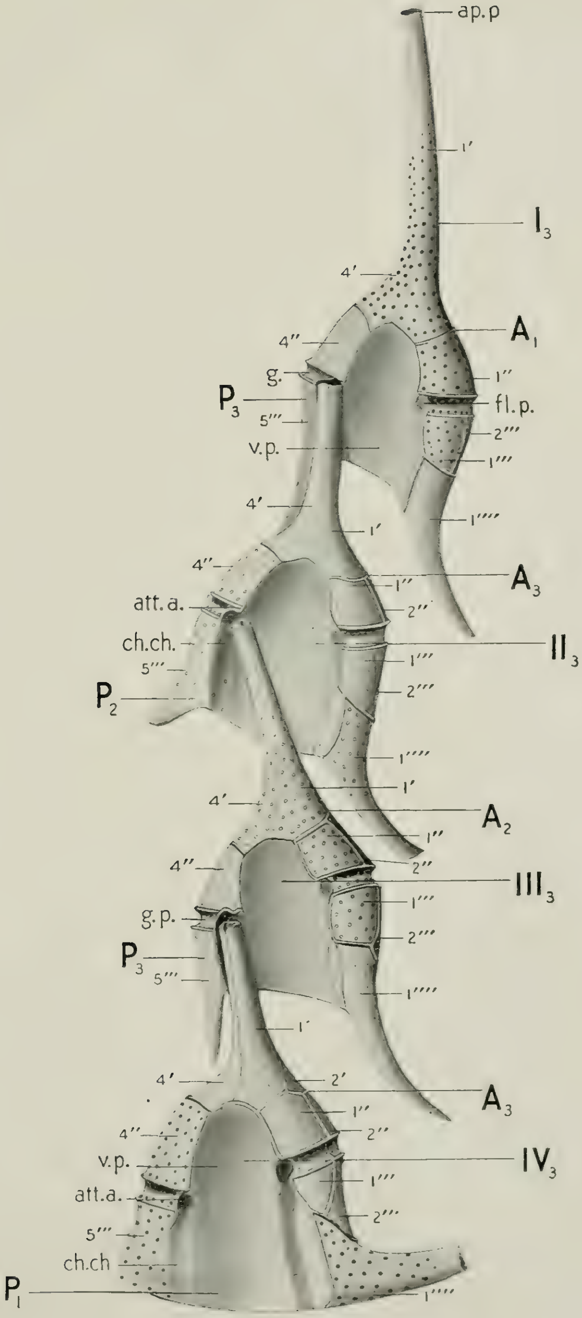
EXPLANATION PLATES.

PLATE 1.

Fig. 1. Ventral view of mutating chain of Ceratium. Posterior cell (IV_3) is *Ceratium tripos*, the other three (I_3, II_3, and III_3) are *C. californiense.* A_1, A_2, and A_3 are anterior, and P_1, P_2, and P_3 posterior skeletal moieties formed on the cells of the first, second, and third generations respectively. A heavier suture marks the fission line (*f. l.*). The apical pore (*ap. p.*) is at the anterior end of the apical horn, the flagellar pore (*fl. p.*) at the proximal end of the girdle (*g.*), and the attachment area (*att. a.*) at its distal end. The chain channel (*ch. ch.*) lies to the rear of this area along the side of the ventral "plate" (*v. p.*). The skeleton consists of the following plates: Apical series of plates ($1'$–$4'$), precingular plates ($1''$–$4''$), girdle plates (*g. pl.*), postcingular plates ($1'''$–$5'''$), antapical plates ($1''''$–$2''''$), and the so-called "ventral plate." × 540.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IV_3
att.a.
1'''
5'''
2'''
ch.ch
P_1
1''''

PLATE 2.

Fig. 2. Dorsal view of the same chain. Labelling as in plate **1**. Note the thinning of the skeletal wall in the antapical regions. Cell III_3 is seen somewhat obliquely, reducing its transdiameter. See pls. **1** and **3** for its normal dimensions. × 540.

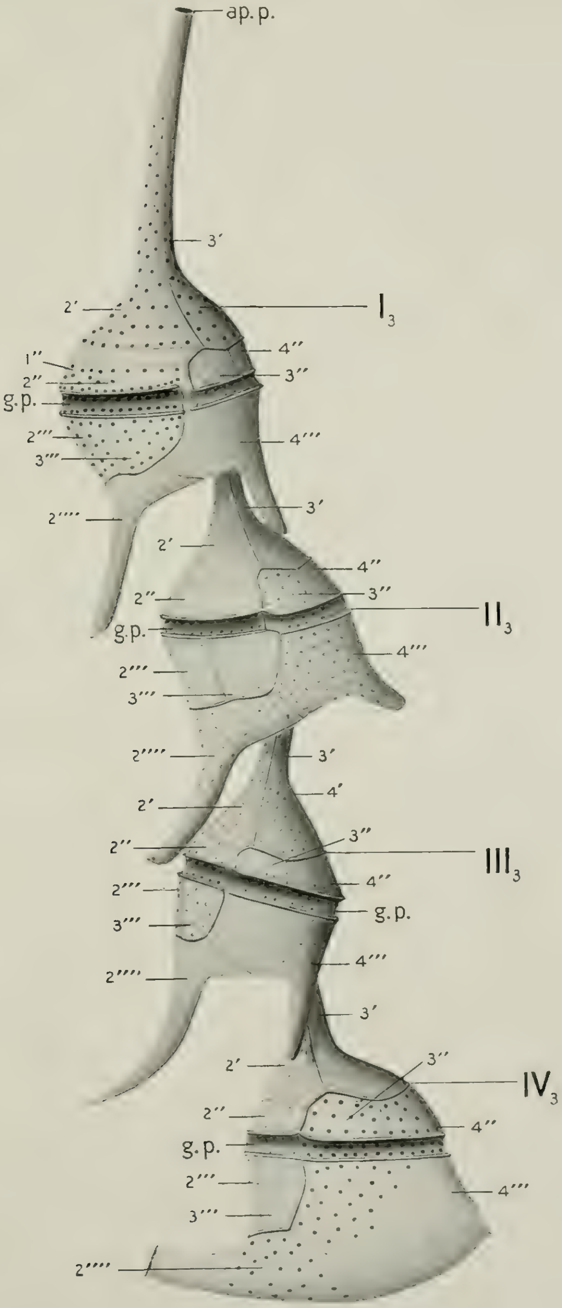

ap. p.
3′
2′
I$_3$
4″
1″
3″
2″
g. p.
2‴
4‴
3‴
2⁗
3′
2′
4″
3″
2″
II$_3$
g. p.
4‴
2‴
3‴
2⁗
3′
4′
2′
3″
2″
III$_3$
4″
2‴
g. p.
3‴
4‴
2⁗
3′
3″
2′
IV$_3$
2″
4″
g. p.
2‴
4‴
3‴
2⁗

PLATE **3**.

Fig. 3. Cell contents of the mutating chain shown in plates **1** and **2**. The nuclei (*n.*) of the four cells are shown in mitosis more advanced posteriorly than anteriorly. × 540.

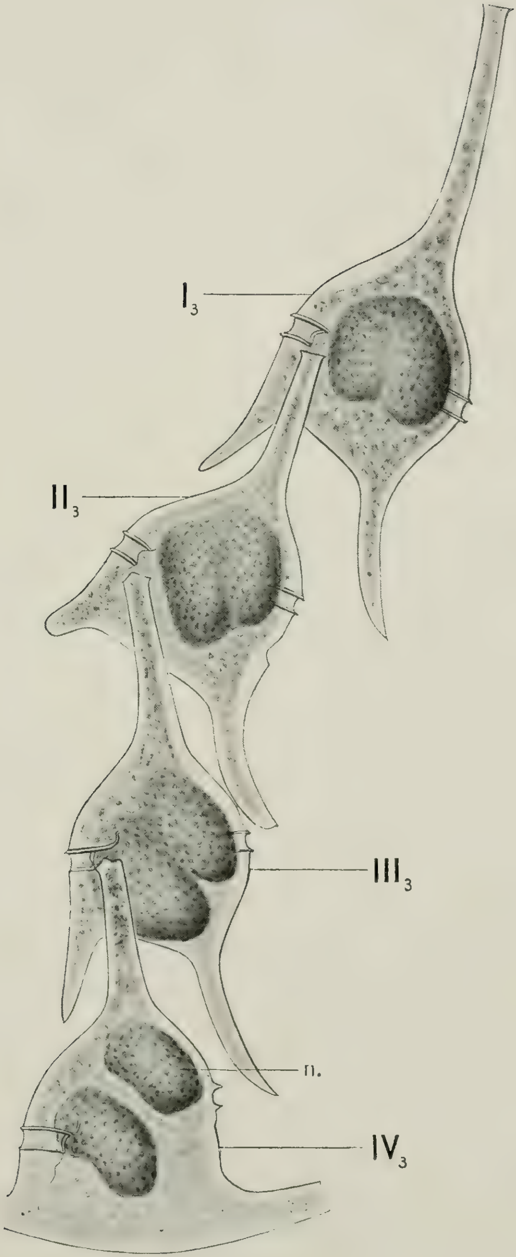

I_3
II_3
III_3
n.
IV_3

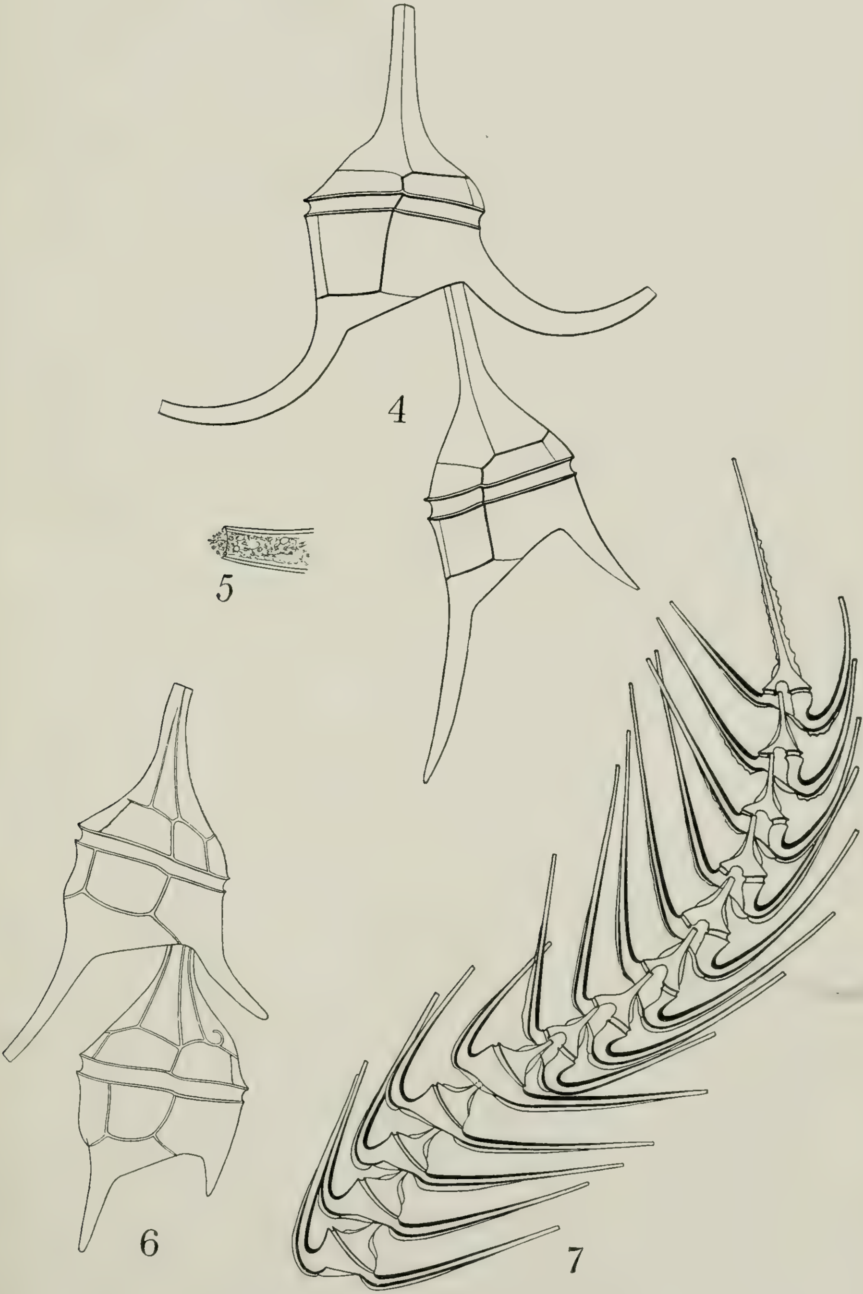
PLATE 4.

Fig. 4. Mutating chain of Ceratium, dorsal view. The anterior cell is *C. ostenfeldi* (?); the posterior, *C. californiense.* × 540.

Fig. 5. Tip of antapical of anterior cell of the chain shown in fig. 4. × 467.

Fig. 6. Mutating chain of Ceratium. Anterior member is *C. californiense,* and posterior one resembles *C. ehrenbergi* (?), dorsal view. × 450. Station 4740.

Fig. 7. Normal chain of *C. vultur,* twisted at the fifth cell from the rear, showing ventral view anteriorly, and dorsal, posteriorly. × 100. Station 4713.



Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LII. No. 14.

MYLOSTOMID PALATAL DENTAL PLATES.

By C. R. Eastman.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
December, 1909.

No. 14. — *Mylostomid Palatal Dental Plates.* By C. R. Eastman.

The publication (Mem. N. Y. Acad. Sci., 1901, **2**, pt. 3) of an important article by Dr. Bashford Dean "On the characters of Mylostoma Newberry" marked a signal advance in our knowledge of this genus of Arthrodires. The thesis referred to possesses the further distinction of having made known for the first time nearly all the hard parts, including the palatal and mandibular dental plates, of a single individual.

Dean's theoretical restoration of the dentition in the example studied by him, in which the component parts were slightly disarranged, was accepted as valid for the next four or five years, when another tolerably complete individual, the type of which is preserved in the Peabody Museum at Yale University was described under the name of *Dinomylostoma beecheri* (Bull. M. C. Z., 1906, **50**, p. 23). In the light of new evidence furnished by this second unusually perfect individual, Dean's interpretation of the upper dental pavement of Mylostoma was modified in several respects, notably as regards the presence of true vomerine teeth (corresponding to the so-called "premaxillaries" of Dinichthys) in the upper jaw, anterior to the two pairs of palato-pterygoid crushing plates.

Some discussion has taken place during the last three years as to the correctness of the two extant interpretations of Mylostomid dentition. Dean's view is supported chiefly by himself, but in part also by Dr. L. Hussakof, in several articles that have appeared in Science, 1907–1908, and in the publications of the American Museum of Natural History. For a recent formulation of the newer hypothesis it will suffice to refer to the memoir on Devonian Fishes, published in volume 18 of the Iowa Geological Survey Reports.

As matters now stand, it is a demonstrated fact that Mylostomids are characterized by the possession of two pairs of tritoral pavement plates in the upper jaw, and that at least one genus, Dinomylostoma, is provided with still another, somewhat smaller pair of plates in advance of these, making a total number of three pairs of upper dental plates in all.

Whether Mylostoma proper possessed the basic number of three pairs of plates in the upper jaw has not yet been determined by positive evidence. Certain detached triangular elements that were provisionally interpreted by Newberry as "premandibular" plates belonging to the type species of Mylostoma, and afterwards by the present writer as vomerine teeth referable to the same form, have since been assigned to the lower jaw of a distinct species, named *M. newberryi* (Bull. M. C. Z., 1907, **50**, p. 224). Reasoning from analogy, however, the presence in Mylostomids of vomerine teeth, which are the morphological equivalents of the so-called "premaxillary" (in reality *vomerine*) teeth of Dinichthys, becomes a necessary postulate.

Thus far decisive evidence has been lacking which shall enable us to establish the homologies between the several components of Mylostomid and Dinichthyid dentition. For, if we accept Dean's interpretation and regard one of the pairs of pavement plates in Mylostoma as the modified "premaxillary" (*i. e.*, vomerine) teeth of Dinichthys, we shall perforce have to deny the possible occurrence of a third pair of plates in this genus, corresponding to the most anterior of the trio that have been definitely proved to belong to Dinomylostoma. Taking this latter fact, however, for our point of departure, and noting the obvious correspondence between the similarly placed vomerine teeth in Dinomylostoma and Dinichthys, it follows that the two pairs of pavement plates in Mylostomids generally must together correspond to the single large sectorial plate or "shear-tooth" of Dinichthys. The latter, therefore, according to this view, is to be regarded as a morphologically compound plate, made up of the fusion of two elements that remain separate in more primitive forms; and as a corollary to this theory, the discovery at some future time of true vomerine teeth in Mylostoma may be confidently expected.

Up to the present time material has been lacking which shall permit a complete verification of either of the above alternative hypotheses. Neither has the precise arrangement of the two pairs of Mylostomid dental plates been demonstrated by the discovery of the undisturbed upper dental pavement belonging to a single individual, or even such portions of the pavement as can clearly be proved to have been preserved in normal position. In the single nearly complete individual studied by Dean the two plates belonging to the right-hand side of the palatal pavement are indeed juxtaposed in the matrix of the containing slab. (Fig. 1.)

Although at first sight these tritoral plates might be supposed to be oriented in natural position with respect to each other, arguments based upon the mutual adjustment and interplay of various parts have

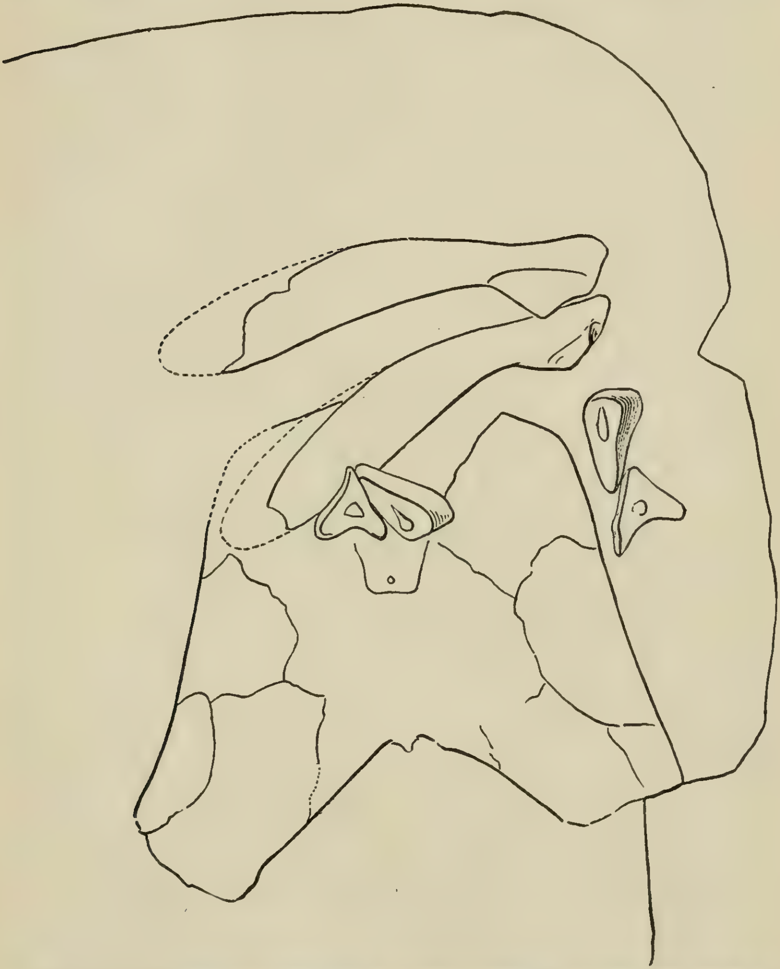


Fig. 1. Outline sketch showing the position in which the constituent parts of the dentition were embedded with respect to the headshield containing the single individual of *Mylostoma variabile* juv. described by Dean. x $\frac{1}{3}$ (after Dean).

been brought forward, whose combined force is seemingly incontrovertible, and the effect of which is to negative the foregoing assumption. And inasmuch as this premise lies at the very starting-point of Dean's theoretical reconstruction of Mylostomid dentition, so that the adequacy of his conclusions depends upon the trustworthiness of his initial conjecture, it will be seen that it is a matter of vital importance to ascertain the true arrangement of these two pairs of palatal (or more properly, palato-pterygoid) dental plates.

Means for applying a critical test to the two theoretical reconstructions of parts that have been proposed has fortunately come to light during the present year. This consists of a single very peculiar dental plate, undoubtedly of Mylostomid nature which Dr. L. Hussakof describes (Bull. Amer. Mus. Nat. Hist., May, 1909, **26**, p. 269), under the name of *Dinognathus ferox* n. gen., n. sp. In the opinion of the present writer, this singular plate, which is of perfect bilateral symmetry and therefore assignable to a median position in the mouth, cannot be interpreted otherwise than as the fused pair of anterior palato-pterygoid dental plates common to Mylostomids, using this term in the sense that it has been heretofore employed for the type species of Mylostoma. That is to say, under the term of anterior palato-pterygoid plates are to be understood the narrow and elongate subtriangular elements which are especially characterized by having straight vertical edges along their mutual contact faces where the right- and left-hand elements were in apposition with each other in the median line. We have merely to suppose fusion to take place along these smooth and firmly adpressed edges, in order to produce the symmetrical hippocrepiform outline exhibited by the compound plate which is rightly made by Dr. Hussakof the type of a new genus, Dinognathus. The sinuous lateral margins, beveled edges, expanded anterior and contracted posterior moieties of this plate, together with the forwardly placed median tubercle of the oral surface, are among the features which bring this plate into harmonious relations with the two corresponding elements in *M. variabile*. The general form and proportions of the plate, its relative thickness, and, as noted by Dr. Hussakof, the density of its surface texture, all testify to the correctness of the interpretation here advocated, and no characters can be distinguished which militate against it. The size of the single compound plate in Dinognathus does not greatly exceed that of its two morphological equivalents in *M. variabile*, and agrees to a nicety with the proportions indicated by the type mandible of *M. terrelli*. Indeed, there are most excellent reasons for maintaining a provisional association of the parts originally referred to two distinct genera and species, namely, the above-mentioned type mandible of *M. terrelli*, and the compound anterior palato-pterygoid dental plate of Hussakof's so-called *Dinognathus ferox.* An inspection of Figure 2, in which no reduction in scale nor alteration of the natural outlines has been necessary, will convince one of the harmonious coadaptation of parts. The existence of a posterior pair of palato-pterygoid dental plates in this new Mylostomid genus may be regarded as an absolute certainty, and the presence of vomerine teeth as a reasonable presumption.

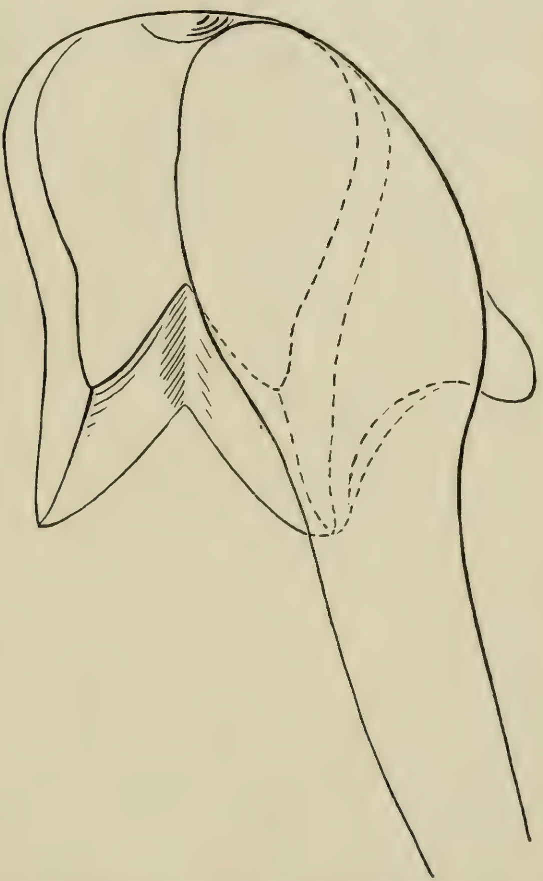


FIG. 2. Proposed reconstruction of Dinognathus type of dentition, showing correspondence in area and outline between the mutually interacting parts (upper and lower dental plates). The missing posterior palato-pterygoid element is restored from analogy with *Mylostoma variabile.* x $\frac{3}{4}$.

The complete dental apparatus, portions of which have been referred, according to our view, to two distinct "species" and even genera, should henceforth bear the designation of *Dinognathus terrelli* (Newberry). Not only does the solitary mandible upon which this species was originally established (now the property of the Museum of Comparative Zoölogy) differ in appreciable respects from the type of *M. variabile*, but the more compactly formed upper dental pavement — as witnessed by the type of Hussakof's so-called *Dinognathus ferox* — justifies the recognition of generic differences between it and other known Mylostomids. Figures 2 and 3 afford means for a comparison of the restored palatal dentition of Dinognathus and Mylostoma.

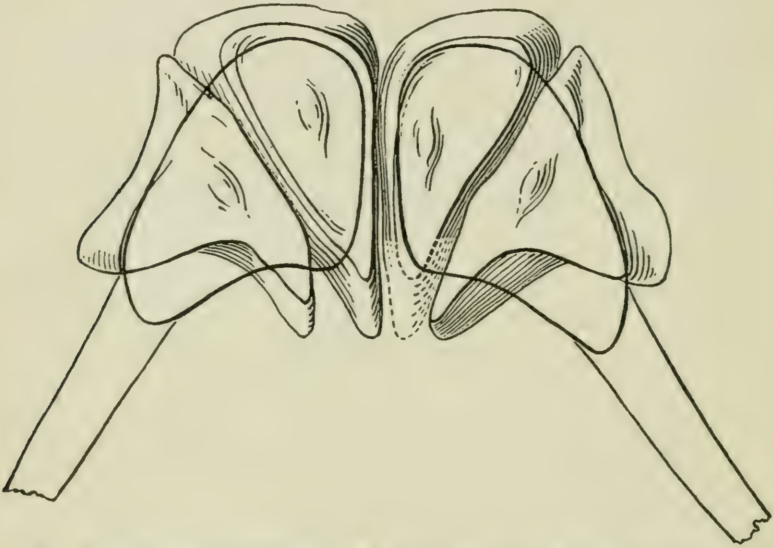


Fig. 3. Proposed reconstruction of Mylostomid type of dentition, based upon the originals shown in Figure 1. One of these elements together with the containing slab is preserved in the Museum of Comparative Zoölogy (Cat. No. 1490); the remaining elements and opposite half of the counterpart in the American Museum at New York (Cat. No. 7526). x ½.

The manner of application of a critical test to our hypothesis will be apparent from a study of the above illustrations. For it will be observed first of all that there is no possible doubt that the compound crushing plate of the so-called *D. ferox* type must have occupied a median position in the dental pavement of which it formed a part. And in order to have operated effectively against the oral surface opposed to it by the two halves of the inferior dentition, that is, the right and left mandibular dental plates, it must needs have been both median and anterior in position. This initial step in assigning the position of the plate in question is clearly imperative.

Secondly, it is obvious that whatever other elements may have been concerned in the formation of the upper dentition of Dinognathus, they must have been disposed so as to function against the remaining posterior portion of the opposed mandibular dental plates; in effect, against all that portion of the inferior dentition which is shown by marks of wear and other features to have reciprocated with the upper, but whose spatial limits extend beyond the area of interplay with the compound median anterior element. The approximate form and size of this second posteriorly placed pair of palatal dental plates are therefore predetermined in advance of their actual discovery by our knowledge of the conformation of the mandibular dental plate in typical Mylostomids, and again, in still another way, by analogy with the hinder pair of palatal plates such as are already known in other species and genera.

Bearing these considerations in mind, one readily perceives that of the two pairs of plates constituting the upper pavement dentition of the type species of Mylostoma, only the narrow and elongate anterior pair is capable of being homologized with the similarly situated compound plate in Dinognathus, which latter, for convenience of distinction in the present discussion, may be referred to as the "ferox" type of Mylostomid palatal plate. For it is clear that only the members of this particular pair admit of being symmetrically arranged on either side of the median axis so as to present even a remotely similar configuration, whereas the combined outline of the pair chosen for comparison betrays essentially the same pattern and proportions as are to be observed in the "ferox" type of plate. Manifestly, the resemblance is too intimate to be ascribed to a chance coincidence. And finally, any attempted interchange of the two sets of pavement plates which we have uniformly designated as anterior and posterior pairs, both in this and former articles (Bull. Mus. Comp. Zoöl., 1906, 1907, **50**, Nos. 1, 7), instantly throws their functional surfaces out of adjustment for interplay with the lower dentition.

Hence it follows that the new "ferox" type of Mylostomid dental plate serves as a valuable criterion for fixing the precise homologies of the two pairs of pavement plates in the type species whose relations have been in dispute, and for confirming the validity of that reconstruction of the palatal dentition which is represented in Figure 3. To judge of the efficiency of the critical test here employed, we have merely to satisfy ourselves that the new form of compound plate made known by Dr. Hussakof is the exact morphological and also functional equivalent of the anterior pair of palatal plates in Mylostoma.

We will not now undertake to prove this equivalency of parts; but let it be granted, for sake of argument, that it exists. The immediate consequence is that one of the three pairs of upper dental plates in Mylostomids becomes definitely fixed in position; and its allocation necessarily serves at the same time to fix the position of the other two. We are thus provided with means for distinguishing absolutely between vomerine and either of the two succeeding pairs of palatal teeth, besides being able to assign each pair to its normal position with respect to the others. In addition, we are enabled to establish definite homologies between the several components of Mylostomid and, let us say, Dinichthyid dentition — or even the dental apparatus of other groups of Lung fishes.

Again, in the light of the foregoing discussion, it must be acknowledged that among different genera of Mylostomids the full complement of upper pavement plates may exist as discrete entities (*e. g.*, Dinomylostoma), or in certain forms the total number may be more or less reduced by fusion. Dinognathus illustrates fusion between the members of the anterior pair of palato-pterygoid dental plates. Up to the present time no Mylostomid genus is known which displays the two pavement plates on either side of the mouth fused into a single piece. Yet there is no inherent improbability that such a condition of affairs might exist, and as a matter of fact this is the identical condition which does exist — among the Dinichthyid group of Arthrodiran fishes. The evidence of Dinognathus regarding the extent to which fusion is capable of taking place among the upper dental elements of Arthrodires is confirmatory of the view of an exact homology between the so-called "shear-tooth" of Dinichthys and the two pairs of tritoral pavement plates in Mylostomids. Unquestionably the similarly formed and similarly disposed vomerine teeth of Dinichthys and Dinomylostoma stand in perfect mutual correspondence; and furthermore the Dinichthyid "shear-tooth" corresponds to the two pairs of Mylostomid pavement teeth.

The objection has been urged, however (Science, July 12, 1907), that the Dinichthyid "shear-tooth" is a single large plate, and proof is wanting that it is of compound nature, or arose from fusion of two distinct elements. But this argument does not hold in the light of new evidence that has fortunately come to hand in Dinognathus. For if two primarily distinct elements can unite in the manner revealed by the "ferox" type of crushing plate, the same process might have happened quite as readily under favoring mechanical conditions in a related genus, family, and group. That it actually *did* happen among Ctenodipterines, as evidenced by *Heliodus lesleyi*, Synthetodus and other forms, has long been known; and we now contend that the same process took place also in Dinichthys, in such manner as to produce the powerful and elongate compound "shear-tooth." Granting the truth of this proposition, it follows that the vomerine or so-called "premaxillary" teeth of Dinichthys cannot be homologized with either of the two pairs of Mylostomid pavement plates, but are to be regarded as the precise equivalent of the most anterior of the three pairs of upper dental plates (*i. e.*, vomerines) that have been proved to occur in Dinomylostoma. The far-reaching consequences of this interpretation have been sufficiently elaborated in previous numbers of this Bulletin.

Following is a list of the known genera and species of American Mylostomids:

MYLOSTOMATIDAE.

1. **Dinomylostoma beecheri** Eastm. Portage beds of the Upper Devonian; Mt. Morris, Livingston County, New York.
2. **Mylostoma variabile** Newberry. Cleveland shale (Upper Devonian); near Sheffield, Ohio.
3. **Mylostoma newberryi** Eastm. Cleveland shale; near Sheffield, Ohio.
4. **Dinognathus terrelli** (Newberry). Cleveland shale; Erie and Lorain Counties, Ohio.
5. **Diplognathus mirabilis** Newberry. Cleveland shale; Lorain County, Ohio.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LII. NO. 15.

NOTES ON THE HERPETOLOGY OF JAMAICA.

BY THOMAS BARBOUR.

WITH TWO PLATES.

CAMBRIDGE, MASS., U.S.A.:
PRINTED FOR THE MUSEUM.
MAY, 1910.

No. 15. — *Notes on the Herpetology of Jamaica.*

By Thomas Barbour.

Introduction.

On the return from a trip to South America the writer stayed somewhat more than a month (March–April, 1909) in Jamaica. The opportunity was taken for collecting a considerable series of reptiles and amphibians, and as great changes have taken place, and are still taking place, affecting the abundance of many species it seems desirable to prepare the following outline of the Herpetology of the island. The introduction of the mongoose (*Herpestes griseus* E. Geoff.) has caused the almost complete extinction of many species which were once abundant, and has in some ways radically changed the facies of the fauna.

In the back country lizards are rarely met with, and it is only in the vicinities of villages and towns, where they are more or less protected, that one may obtain satisfactory series of many species. The true ground-inhabiting forms have, of course, suffered most, so that lizards of the genera Ameiva, Mabuia, and Celestus are now scarce and difficult to obtain. This is all the more unfortunate because the members of the last-named genus were particularly interesting, local in distribution, retiring in their habits, and even, before the introduction of the mongoose, rare in collections.

Snakes have suffered perhaps more than lizards. The general opinion in Jamaica is that the Boa, Epicrates, as well as the large Iguana, are now almost extinct on the main island, though they still occur on some of the near-by outlying islets. As for other snakes, the racers are now scarce and difficult to obtain, while the burrowing snakes are, owing to their habits, of uncertain occurrence. There is no reason to suppose, however, that their abundance has been affected by the spread of the mongoose.

The amphibians are quite plentiful. The large tree frogs may be heard almost any night or during showers in localities slightly above the level of the sea. I have never heard any near the sea-coast towns. The Hylas generally spend most of their time hiding in the clumps of what the natives call "wild pines" (Bromeliaceae), which are epiphytic on many species of Jamaican trees.

Fresh-water turtles are not uncommon in certain localities, though perhaps, from the fact that they are eagerly sought after by the negroes, they are shy and hard to obtain.

Mention of the sea turtles has been omitted because there is nothing in their habits or distribution of particular interest. Generally speaking, all the species are becoming scarcer about the islands. Turtlers from Kingston now scour the coast of Central America, travelling back and forth in small almost open schooners. The Green turtles are sent to market in London, while the shell of the Hawksbill is prepared to some extent in Jamaica.

Under the separate discussion of the various species of lizards a considerable number of notes on the local distribution of each have been included. The ranges of many forms are surprisingly restricted, and it is very unusual to find the same species of lizard the most common one in any two localities, which are separated even by comparatively short distance. Notes made on species identified on a number of trips through the island in various directions, as well as specimens actually collected in different localities, serve to bring out this point.

I have drawn much valuable aid from Stejneger's "Herpetology of Porto Rico" (Ann. Rept. U. S. Nat. Mus. for 1902, 1904, p. 549–724, 1 pl.), as well as from Dr. Stejneger himself.

I desire to thank my friend Dr. J. L. Bremer for his assistance in making the collections.

I have used the specimens and valuable field notes of Mr. A. E. Wight, and also other material in the Museum from various sources.

LITERATURE.

There have been but comparatively few works which dealt with the herpetologic fauna of Jamaica in any fulness. Many of the species were described in scattered publications, and these may be easily referred to from the citations of original descriptions. In 1851, however, Philip Henry Gosse published his classic, "A Naturalist's Sojourn in Jamaica." This charming book contains many references, which, while they throw comparatively little light on the subject of the local distribution of the various reptiles, still have a great value in showing the abundance of many species half a century ago, as compared with their abundance at the present time. Under each species Gosse's notes have been added where they now seem pertinent to the subject. During the time that Dr. J. E. Duerden had charge of the collections of the Institute of Jamaica he published a list of the lizards of the island in a Kingston newspaper called "The Daily Gleaner." This appeared on July 18, 1896, and contained remarks on twenty-three species mostly in the collections preserved in the Institute museum. These specimens were nearly all destroyed in the Kingston earthquake, as were also the newspaper files in the "Gleaner" office. Duerden's notes are valuable and are incorporated here from transcriptions taken from a clipping in a scrap book in the Institute library.

Besides the publications of Gosse and Duerden, Mr. Samuel Garman in 1887 contributed to the Bulletin of the Essex Institute in Salem a short series of important studies on West Indian reptiles and amphibians. Among these notices of Jamaican species occur. Prof. E. D. Cope in 1863 and again in 1894 characterized new Jamaican species in the Proceedings of the Academy of Natural Sciences of Philadelphia. The latter paper is an account of material collected by the West Indian Expedition of the University of Pennsylvania during part of 1890 and 1891. Only nine species were mentioned (p. 437–441) as taken in Jamaica.

Geographical Relationships of the Jamaican Fauna.

In analyzing the make up of the Jamaican herpetological fauna, we find that out of a total of thirty-four species the following twenty-five species are peculiar to the island.

1. Eleutherodactylus luteolus (Gosse).
2. Eleutherodactylus jamaicensis Barbour.
3. Hyla brunnea Gosse.
4. Hyla lichenata (Gosse).
5. Sphaerodactylus richardsonii Gray.
6. Sphaerodactylus goniorhynchus Cope.
7. Sphaerodactylus oxyrhinus Gosse.
8. Sphaerodactylus gilvitorques Cope.
9. Sphaerodactylus argus Gosse.
10. Sphaerodactylus dacnicolor Barbour.
11. Cyclura lophoma Gosse.
12. Xiphocercus valenciennesii (Dum. & Bibr.), monotypic genus peculiar to Jamaica.
13. Anolis garmanii Stejneger.
14. Anolis lineatopus Gray.
15. Anolis iodurus Gosse.
16. Anolis opalinus Gosse.
17. Anolis grahamii Gray.
18. Celestus occiduus (Shaw).
19. Celestus crusculus (Garman).
20. Celestus impressus Cope.
21. Ameiva dorsalis Gray.
22. Mabuia sloanii (Daudin).
23. Epicrates subflavus Stejneger.
24. Leimadophis ater (Gosse).
25. Leimadophis callilaemus (Gosse)

Nine species remain to be mentioned. Of these, two have been artificially introduced. They are *Bufo marinus* (Linné) and *Eleutherodactylus martinicensis* (Peters). Besides these it is very probable that *Gonatodes albogularis* (Dum. & Bibr.) has spread accidentally from Cuba. The other gecko *Aristelliger praesignis* (Hallowell), which is not confined to the island, should probably be included in the list of peculiar species; the species described from the islands off the Central American coast is probably distinct, the ones on the Caymans were possibly carried there by the turtling schooners. *Anolis sagrae* Dum. & Bibr. and *Typhlops lumbricalis* (Linné) have a wide range through the West Indian region and their distribution is hard to explain. As for *Tropidophis maculata* (Bibron) I have refrained from defining its range. The Museum has specimens from Haiti which are the same as the Jamaican; we have, however, no Cuban examples, so that no evidence is available as to the similarity of these with Jamaican specimens. Regarding the presence of the fresh-water turtle *Pseudemys palustris* (Gmelin) and the crocodile *Crocodilus americanus* Laurenti there is nothing especially noteworthy. The latter probably reached the islands by swimming and may do so still occasionally, for crocodiles often get far out to sea. The turtle, however, has doubtless been long established, and more material will very probably prove the existence of island races evolved through isolation.

Thus, in conclusion, we may say that the island has twenty-five peculiar species.

The derivation of the species is in most cases evident, and falls into two groups, those which have come through the Lesser Antillean chain from northeastern South America, and those which have come from directly west. Dr. Stejneger in his careful résumé of the origin of the fauna of Porto Rico in his Herpetology of that island has shown that there the first-mentioned group is strongly predominant. This is to be expected from the geographical position of that island. In Jamaica the fauna is almost wholly composed of genera or groups of species as Eleutherodactylus, Celestus (derived from the Central American Diploglossi), Mabuia, Epicrates, which have reached the Greater Antilles from Central America. As in Porto Rico the Sphaerodactyli and Anoles seem also intimately related to forms from the West, and the single Ameiva and the Typhlops suggest very strongly Lesser Antillean affinities. The two species of Leimadophis are of a genus characteristically Antillean and which doubtless developed on the once existing land mass almost continental in size. They suggest the joining of Jamaica to Antillea as other species do the connection with Central America. A marked divergence from the characteristic Greater Antillean fauna is the absence of Bufo and Amphisbaena. On the other hand, the island shares with San Domingo the peculiar genus Aristelliger. The autogenus Xiphocercus is generically separable from Anolis, from which it has been derived.

A peculiarity of the fauna of Jamaica is the fact that while its proximity to Cuba is practically the same as its distance from Haiti, the evident relationship of the island's fauna with that of Haiti is well marked, while with Cuba it has in common only species which range widely through the West Indian region. Now a possible explanation of this offers itself when we examine a contour map of the Caribbean Sea. One of these was published as Fig. 57 in Mr. Alexander Agassiz's "Three Cruises of the Blake" (Bulletin of the Museum of Comparative Zoölogy, 1888, **14**). Mr. Agassiz showed here that the Bartlett Deep, of over 3000 fathoms, extends between Cuba and Jamaica — doubtless a cleft of very ancient origin. The depth of water, however, between the great southern arm of Haiti and Jamaica is only from 500 to 800 fathoms. There is, it is true, a hole of a depth greater than this south of the Formigas Bank. This, however, is very limited in area, and does not fundamentally affect the condition of affairs. The water between Jamaica and the Mosquito Coast of Central America is, much of it, extremely shallow, mostly 100 fathoms or less; though between the Pedro Bank and the Rosalind Bank there is a narrow stretch of water of about 500 fathoms depth.

Hydrographically, then, Jamaica is intimately related with both Central America and Haiti, and it seems probable that Lesser Antillean species and Central American species have come through a land connection which had nothing to do with Cuba. This would account, for instance, for the presence of Aristelliger in Haiti and Jamaica. The early separation of Jamaica from the mainland and from Haiti would account for the absence of types having such a distribution as Bufo and Amphisbaena; which may easily have reached Haiti from the mainland of Central America by way of Cuba. For another connection must have existed between Cuba and the upper peninsula of Haiti after the separation of Jamaica from Haiti, and may we not suppose that the separation took place before the migration of Bufo or Amphisbaena had extended far enough to have reached Jamaica before it was separated?

That the question is far more complex than the suggestions contained in the previous paragraphs would indicate is undoubted. Wallace, in his "Geographical Distribution of Animals" (London, 1876, **2**, p. 81), says: "The West Indian Islands have been long isolated and have varied much in extent. Originally, they probably formed part of Central America, and may have been united with Yucatan and Honduras in one extensive tropical land. But their separation from the continent took place at a remote period, and they have since been broken up into numerous islands, which have probably undergone much submergence in recent times. This has led to that poverty of the higher forms of life, combined with the remarkable speciality, which now characterizes them; while their fauna still preserves a sufficient resemblance to that of Central America to indicate its origin." Masterly as is the above résumé of the status of conditions in the region under discussion, we cannot but doubt that Dr. Wallace would have written somewhat differently had he penned these lines a quarter of a century later. Probably his "West Indian Islands" refer to the Greater Antilles only, and even so, we now know, as already stated, that throughout almost all of these there are two elements in the fauna, Central American and Northeastern South American, which have come to Cuba, Jamaica, Haiti, and Porto Rico by a land connection stretching westward and southeastward.

Another view resting solely on geological or physiographical evidences is that presented by Dr. R. T. Hill, who conducted investigations on the geographic relations of the West Indies under the auspices of Mr. Agassiz. In an article published in the "National Geographic Magazine" (May, 1896, **7**, p. 181), he concludes with these words: "The Greater Antilles lie along the line of east-west corrugations and apparently represent nodes of greater elevation whereby the surfaces of these islands were projected above the waters as islands, which have persisted without continental connection or union with each other since their origin."

If we accept Mr. Hill's conclusions as he has summed them up in the sentences quoted, it is impossible to account for a West Indian flora and fauna except by riding to death again the old theory of "flotsam and jetsam." Ocean currents and prevailing winds could never have carried Central American types to any of the islands, as they work strongly in an opposing direction. This alone serves to prove the utter impossibility of Hill's conclusion. Even were winds and currents favoring, we know now that the number of types which will withstand a long submersion in sea water is vastly smaller than was once supposed when it was thought that reptiles, amphibians, land molluscs, and in fact almost all orders of animals were carried hither and thither throughout the oceanic areas. This question has been most convincingly discussed by Scharff, Beddard, Semper, and others.

Mr. Agassiz has expressed an opinion on this series of relationships in his chapters in "The Three Cruises of the Blake" entitled "American and West Indian Fauna and Flora," and "Permanence of Continents and Oceanic Basins." The following (*loc. cit.*, **14**, p. 111) is pertinent:

"At the western end of the Caribbean Sea the hundred-fathom line forms a gigantic bank off the Mosquito coast, extending over one third the distance from the mainland to the island of Jamaica. The Rosalind, Pedro, and a few other smaller banks, limited by the same line, denote the position of more or less important islands which may have once existed between the Mosquito coast and Jamaica. On examining the five-hundred-fathom line, we thus find that Jamaica is only the northern spit of a gigantic promontory, which perhaps once stretched toward Hayti from the mainland, reaching from Costa Rica to the northern part of the Mosquito coast. There is left but a comparatively narrow passage between this promontory and the five-hundred-fathom line which encircles Hayti, Porto Rico, and the Virgin Islands in one gigantic island.

"The passage between Cuba and Jamaica has a depth of over three thousand fathoms, and that between Hayti and Cuba is not less than eight hundred and seventy-three fathoms in depth."

Referring to the same subject, Mr. Agassiz writes (p. 112–113):

"At the time of this connection, if it existed, the Caribbean Sea was connected with the Atlantic only by a narrow passage of a few miles in width between St. Lucia and Martinique, by one somewhat wider and slightly deeper between Martinique and Dominica, by another between Sombrero and the Virgin Islands, and by a comparatively narrow passage between Jamaica and Hayti. The hundred-fathom line connects the Bahamas with the north-eastern end of Cuba; the five-hundred-fathom line unites them not only with Cuba, but also with Florida. The Caribbean Sea, therefore, must have been a gulf of the Pacific, or have been connected with it by wide passages, of which we find the traces in the tertiary and cretaceous deposits of the Isthmus of Darien, of Panama, and of Nicaragua. Central America and northern South America at that time must have been a series of large islands, with passages leading between them from the Pacific into the Caribbean."

And on page 113: —

"While undoubtedly soundings indicate clearly the nature of the submarine topography, it by no means follows that this ancient land connection did exist as has been sketched above. At the time when the larger West India Islands were formed and elevated above the level of the sea, they may have been raised as one gigantic submarine plateau of irregular shape, in which were included the Bahamas, Florida, Cuba, San Domingo, Porto Rico, and the Virgin Islands."

Mr. Agassiz, however (p. 116), finally tends toward opinions very similar to those of Hill:

"The deep soundings (over three thousand fathoms) developed by the 'Blake' south of Cuba, between that island and Yucatan and Jamaica do not lend much support to the theory of an Antillean continent as mapped out by Wallace, nor is it probable that this continent had a much greater extension in former times than now, judging from the depths found on both sides of the West India Islands. This would all tend to prove the want of close connection between the West India Islands and the adjoining continent. It leads us to look, for the origin of the fauna and flora of those islands, to causes similar to those which have acted upon oceanic islands. The proximity of these islands to a great continent has, however, intensified the efficiency of these causes."

If we grant for the sake of argument that the Greater Antilles, like all Oceanic Islands, have received their fauna fortuitously, we must then explain the regularity and consistency with which the fauna has spread from two directions to populate such a great number of separate islands, with and against the prevailing wind and current. We find in the Lesser Antilles that the fauna is of almost purely Northwest South American origin; as we pass thence to St. Thomas and to Porto Rico we note, as Stejneger has shown, the very evident two-fold origin already mentioned. Then in Jamaica and Cuba the balance is in the opposite direction — types of Central American origin predominate. The ancestry of Cricosaura, Amphisbæna, Bufo, and other forms prove that migration to these two islands took place along independent land bridges. The fact that the Jamaican coney belongs to a different section of the genus (Capromys) similar to the Haitian and different from the Cuban species, and that Solenodon occurs in Cuba and Haiti and not now or so far as we know ever in Jamaica, proves or helps to prove the independent connection with Haiti of both Cuba and Jamaica. Finally, in favor of the "bridge theory" Dr. Stejneger in a recent letter writes: "Whatever the mountain structure may show, certainly the geographical distribution of the animals shows that the Greater Antilles have been part of a continent at some time."

That Dr. Stejneger's opinion represents views which are gaining constantly in credence among present-day students of zoögeography there can be no doubt. Dr. R. F. Scharff in his "History of the European Fauna" (London, 1899) cites many experiments to show that land snails are more easily killed by emersion in salt water than many students in the past have supposed. Slugs when in the act of crawling on twigs drop off immediately when subjected to a slight spray of sea water. Scharff (*loc. cit.*, p. 17) continues: "If we supposed, therefore, that a slug had successfully reached the sea, transported on a tree-trunk, the moisture would tend to lure it forth from its hiding-place under the bark, whilst the mere spray would prove fatal to its existence." He adds that species of snails and slugs which lead an underground existence would be much less likely to get started on these sea voyages. The suggestion advanced by Darwin that young snails just hatched might adhere to the fleet of birds roosting on the ground and then be transported, seems improbable. Dr. Scharff in his "European Animals: Their Geological History and Geographical Distribution" (New York, 1907) states that in a letter Dr. Knud Andersen of Copenhagen has informed him that he has examined the legs and wings of many thousands of migratory birds, "that their legs were clean; and no seeds or other objects were found adhering to their feathers, beaks or feet. It has also been proved that birds migrate on empty stomachs."

There is also good authority for the statement that amphibians and earthworms very rarely or never occur on the two shores of a stretch of sea except when there is evidence showing the former existence of a land connection.

To quote again from Scharff (*loc. cit.*, p. 18–20): "The formerly prevalent belief of the permanence of ocean basins has been shaken by the utterances of some of the greatest geologists of our day, whilst many positively assert that what is now deep sea of more than 1000 fathoms was dry land within comparatively recent geological epochs. Thus the Azores are classed by Darwin and Wallace among the oceanic islands — that is to say, among such as have received their fauna and flora by flotsam and jetsam. But Professor Neumayr believes, on geological grounds, that the Old and New Worlds were connected by a land-bridge during Tertiary times right across the Atlantic, and that the Canary Islands, Madeira, and Azores . . . are the last remnants of this continent. This meets with the entire approbation of Dr. von Ihering, who has recently re-investigated the subject from a faunistic point of view. . . . Take another instance of one of Wallace's most typical oceanic islands, the Galapagos Group. Their fauna and flora have recently been most thoroughly re-explored by an American expedition, the result of which, according to Dr. Baur, goes to show that these islands must have formed part of the mainland of South America at no distant date. The fauna and flora are therefore to be regarded as having reached them in the normal mode, viz., by migration on land. According to Mr. Beddard . . . it is difficult to see how earthworms could be transported across the sea. Floating tree-trunks have been observed far out at sea, but unless the water remained absolutely calm during the long period necessary for the drifting by currents, so that no splashing occurred, the worms would probably be killed. Yet earthworms do occur on oceanic islands. It is indeed quite possible that our views with regard to the origin of the remainder of the Pacific Islands may change very materially, and once more revert to what Dr. Gould expressed nearly fifty years ago in the following words: ' From a consideration of the land-shells on the Pacific Islands, it seems possible to draw some fair inferences as to the relations of the lands which once occupied the area of the Pacific Ocean, and whose mountain peaks evidently now indicate or constitute the islands with which it is now studded.' Indeed Dr. von Ihering goes so far as to positively state that in his opinion the Polynesian Islands are not volcanic eruptions of the sea floor, which being without life were successively peopled from Australia and the neighboring islands, but the remains of a great Pacific continent, which was in early mesozoic times connected with other continental land masses. . . ."

Scharff continues (p. 21): "Amphibians are affected in the same manner by sea-water as slugs are. The accidental transportal of an amphibian from the mainland to an island is therefore almost inconceivable. And the presence of frogs, toads, and newts in the British Islands, in Corsica and Sardinia, indicates, if nothing else did, that all these islands were at no distant date united with the continent of Europe."

All these remarks and quotations tend to show that the belief held by the writer is not an unusual one, for certainly the fauna of the Greater Antilles possess vastly more species than do either of the islands previously mentioned, which are among those now generally conceded to be forms which will not survive transportal by the theory of flotsam and jetsam which was so strongly urged by both Darwin and Wallace. And without criticising the unassailable positions which both these men hold as founders of the science of zoögeography, we must agree with Scharff and other more modern students that their theories regarding the origin of the faunae of islands require revision in the light of new data which have come to hand from recent explorations.

Regarding the continental aspect of the faunae of various West Indian islands, one type remains to be mentioned which from its peculiar characteristics renders quite inconceivable its being carried about on floating objects. Peripatus is one of the most delicate of known organisms. Dr. Grabham, a well-known field naturalist, long resident in Kingston, Jamaica, told me that with the greatest care he had never been able to bring a living Peripatus from Bath to Kingston in Jamaica, a distance of thirty-five or forty miles, and my experience has been exactly the same. Last winter it was found absolutely impossible to keep alive at all any of the hundred-odd specimens which were taken in the vicinity of Bath. On the return from a day's collecting many dead specimens of Peripatus were always found in the receptacle in which they were carried, which was filled with the natural earth and moss taken from the spot where the creatures were found. Aside from this, the fact that the creatures are killed in a remarkably short space of time in alcohol, weak formalin, or by an emersion in hot water far below the boiling point, tends to substantiate this view whatever may be true with other species of the group. Now we know that Peripatus occurs not only in Jamaica, where there are two species, but also on the island of Trinidad, on Dominica, on St. Thomas, Antigua, and Porto Rico. The species on Trinidad bears a close similarity to South American forms. The species in the Lesser Antilles and in Porto Rico are very closely related to one another. In fact, Bouvier prefers to consider them sub-species of the long known *Peripatus dominicae.* The Jamaican forms, on the other hand, he groups more with the Central American species, which substantiates the evidence presented by the distribution of the reptiles and amphibians. Again Bouvier in his "Monographie des Onychophores" (Ann. Sci. Nat. Zool., 1907, ser. 9, **2**, p. 72, 73) gives us in succinct form his ideas regarding the distribution of recent Onychophora. From his "Peripatides primitifs" he derives, first of all, two great groups, the Indo-Malayan forms and his "Peripatus andicoles." These groups he shows to differ fundamentally in structure and to represent an extremely early separation. From the latter group he derives directly "Peripatus caraïbes" and lastly from these all the African forms. It may be urged that the connections by which Peripatus reached Antillea have been very ancient indeed, and had nothing to do with more recent ones used by modern types. In view of the fact that a great part of the islands has been under water in recent geologic times it is quite possible that Peripatus utilized the same connections over which more specialized forms have come, so that they may be of importance when rather recent migrations are considered. There seems no reason to believe that there have been several successive approximations of Antillea to the adjacent mainlands.

Calvert, in a recent paper on the "Odonate Fauna of Mexico and Central America" (Proc. Acad. Nat. Sci. Phila., 1908, **60**), says that the actual distribution of the Odonata is determined by the conditions under which their aquatic larvae are able to exist, and that our present information refers to the appearance of the imagos in certain localities, and the summary herewith presented rests on the unproven assumption that the adults do not wander far from the waters in which they have passed their earlier stages or in which their offspring are capable of surviving. There are about 91 species of Odonata known in the West Indies; 56 of these, or 61½ per cent, also occur in Central America. The number of species common to both regions is likely to be increased by future explorations. But making use of the present figures, it is very surprising that only 61½ per cent of the West Indian Odonata are found in Mexico and Central America, seeing that the prevalent winds on the east coast of the mainland are easterly. With such insects as the Odonata one might expect winds to play an important part as means of dispersal.

Scharff quotes Mr. C. T. Simpson, who has had experience of oceanic dispersal in the West Indian region. He has examined floating rafts of bamboo, which would be suitable in the transportal of invertebrates, nevertheless he does not attach much importance to this means of distribution. "The fact," he remarks, "that the operculates (operculate land-shells) form so large a proportion of the Antillean land-snail fauna, that a majority of the genera are found on two or more of the islands and the mainland, while nearly every species is absolutely restricted to a single island, appears to me to be very strong testimony in favour of a former general land connection."

Since the previous notes on the zoögeography were written, Dr. Scharff's paper, "On an Early Tertiary Land-Connection between North and South America" (Amer. Nat., 1909, **43**, p. 513–531), has been received. While this does not deal directly with the West Indies, nevertheless it contains references and statements which leave no room for doubt but that Dr. Scharff does not question the existence of an Antillean continent. His quotation from Ortmann (*loc. cit.*, p. 518) is pertinent: "In place of the present Southern continent he thinks that towards the end of Mesozoic times, there existed the old Brazilian land (Archiplata), an Antillean continent (including the West Indies and Venezuela) and also the Chilean coast range." Again, in discussing Arldt's views, Dr. Scharff says: "His conception of an extensive land having once flourished to the west of Central America, while the latter was largely submerged, is not altogether new. In alluding to the east-westward trend of the Antillean Cordillera and its abrupt termination on the Pacific coast of Guatemala, Professor

Suess makes a suggestion as to its former westward prolongation. Precisely at the point, he says, when the arcuate continuation of this chain might be expected to meet the principal chains of South America, lie the volcanic Galapagos Islands."

Dr. Scharff (*loc. cit.*, p. 523) uses Peripatus to illustrate an archaic group having a remarkable discontinuous distribution.

The writer has no suggestion to offer on the age of the various Antillean connections assumed. Antillea must have persisted until Central America had some such shape as it has at present. For Cretaceous connections such as suggested by Arldt connecting northern South America with western Mexico, would not explain present distributions and would, of course, be too early to have bearing on many existing types. One fact can be clearly proved by the land animals of the islands, namely, that land connections have existed in spite of the claim of many geologists of the "permanence of the continents in their present form," and of others who with Dr. Hill believe that the Antilles have always existed in their present form. Fortuitous distribution has played practically no part in providing the Antilles with a fauna.

VERTICAL DISTRIBUTION.

The hills of Jamaica rise at Blue Mountain Peak to a height of 7423 feet, and in several places are over 5000 feet. Nothing, however, seems especially noteworthy regarding the vertical distribution of species. A' considerable number of notes bearing on this topic are introduced in their appropriate places.

For the benefit of lay visitors to the island it may be said that not a single venomous reptile occurs on the island, in spite of the statements of the natives.

SPECIES DOUBTFULLY RECORDED.

The following forms reported as from Jamaica are without doubt wrongly labeled as to locality:

Phyllodactylus ventralis O'Shaughnessy. The type of this gecko was said to have come from Jamaica. Boulenger questioned the accuracy of this locality in "Catalogue of Lizards," 1885, **1**, p. 80. The species is a Central American one.

Diploglossus monotropis Wiegmann. A specimen of this species is in the British Museum, and served Gray as the type of his *Tiliqua jamaicensis* (Ann. Mag. Nat. Hist., 1839, ser. 1, **2**, p. 293). Boulenger (*loc. cit.*, 1885, **2**, p. 286) has bracketed the locality. This lizard is also Central American.

Anolis equestris Merrem. Duerden included this species in the list of Jamaican lizards already mentioned. He doubtless followed Boulenger (*loc. cit.*, 1885, **2**, p. 21), where the habitat is given as "Cuba, Jamaica." As we know now, the species is confined to Cuba.

Anolis richardii Gray. This species has been reported from Jamaica on the basis of a specimen in the British Museum taken by J. Winterbottom, Esq., and which served Gray as the type of his *A. stenodactylus*, which is, according to Boulenger, synonymous with *A. richardii*. Duerden in the "Gleaner" records this species No. 12 in his list, but remarked that it was very rare, for no specimen had ever been received at the Institute of Jamaica. The supposed Jamaican example was without doubt taken in the Lesser Antilles, to which region the species is confined. A species common to, say, both Jamaica and Dominica would be absolutely foreign to what we know of the distribution of species whose ranges are accurately known and which have not been introduced artificially.

Eleutherodactylus lentus (Cope). Though Cope himself has recorded this lesser Antillean species from Jamaica, there seems to be no reason whatever to suppose that it really occurs there. It was probably *E. luteolus* (Gosse) wrongly identified.

Bufo marinus (Linné).

Rana marina Linné, Syst. Nat., Ed. 10, 1758, **1**, p. 211.

This species, introduced in Jamaica as in so many other West Indian Islands, is now widespread. There are examples in the collections at hand from Kingston, Mandeville, and Port Antonio. Gosse (Nat. Sojourn in Jamaica, 1851, p. 430) states that the introduction took place from Barbadoes in 1844.

Eleutherodactylus luteolus (Gosse).

Plate 2, Fig. 2.

Litoria luteola Gosse, Nat. Sojourn in Jamaica, 1851, p. 366, pl. 7.
Hylodes luteolus Boulenger, Cat. Batr. Sal., 1882, p. 208.

This seems to be the most abundant native amphibian. Gosse has given an excellent figure for the light brown color phase, which is, I think, rather less common than a mottled slate-colored phase in which there is a distinct light vertebral line which bifurcates, sending a branch along the hinder side of the thighs. This species may be easily separated from *E. jamaicensis*, sp. nov. by the very small digital discs and by this vertebral line. The development of this frog is of interest. The eggs from thirty to thirty-five in number are laid in depressions in damp ground under stones or logs. Mr. Wight has also found these nests and writes:

"Port Antonio, Jamaica. Nov. 30. Thirty-three eggs in slight depression, damp ground. Eggs scarcely adherent. Movements of embryos visible. 168 hours later two frogs hatched. After 312 hours the whole lot had taken on the light brown color which is typical of many adults."

The species is confined to Jamaica and seems to be generally distributed over the island. Mr. Garman collected many specimens about Kingston in 1878 (M. C. Z., No. 2044); in 1905 Major Wirt Robinson sent in a series from the same locality (M. C. Z., No. 2427). The Museum has also two specimens from Moneague (No. 2045). Among those recently obtained are many specimens from Kingston, Mandeville, and Port Antonio collected by Mr. Wight and the writer. Several Mandeville specimens measure four inches from nose to tip of outstretched hind toe, which is much larger than measurements of examples from other localities.

Eleutherodactylus jamaicensis, sp. nov.

Plate 2, Fig. 1.

Types: five specimens (M. C. Z., No. 2512), taken March, 1909, at Mandeville, Jamaica, by Thomas Barbour.

Tongue narrow, extensively free and not nicked behind. Vomerine teeth in two arched series, each one beginning behind the center of one of the internal nares and almost meeting the other at the median line. (In *E. luteolus* the series are much more extensive in that they begin laterally beyond the outer limits of the choanae). Nostrils latero-dorsal, one third of the distance from tip of snout to eye. Upper eyelids much narrower than interorbital space. Tympanum rather more than one half the diameter of the eye, its distance from the latter barely one half its diameter. Discs on fingers large and conspicuous, on toes smaller. First finger shorter than second; first toe also short, reaching to second subarticular tubercle of second toe. (The first subarticular tubercle is at the very base of the toe.) Well developed subarticular tubercles throughout. Two metatarsal tubercles, the inner strong and well developed, the outer so small as to be hardly visible. No tarsal fold. The hind limb being carried forward along the body, the tarso-metatarsal articulation reaches to between the eye and the nostril.

Color rather variable. Back brown of varying shades generally darker in mid-dorsal region. Apparently always some indication of a pair of light brown dorso-lateral areas. These may be conspicuous. One specimen has a light vertebral line which does not, however, bifurcate and extend along the thighs as in *E. luteolus.* An irregular triangle of dark brown on top of head, two angles of which lie on the eyelids, while the third extends on the nape and generally merges with the dark dorsal area.

The figure was made with the aid of copious notes taken from living specimens. They have changed, however, but very slightly in spirits.

Eleutherodactylus martinicensis (PETERS).

Hylodes martinicensis Peters, Monatsber. Akad. Wiss. Berlin, 1876, p. 709, pl. 1.

The distinctness of this species from *E. auriculatus* (Cope), found in Cuba, San Domingo, and Porto Rico, has been discussed by Stejneger (Rept. U. S. Nat. Mus. for 1902, 1904, p. 583–584). During a recent visit to Washington he showed me a number of specimens from Hope Gardens near Kingston, Jamaica. These were accompanied by collector's notes, which said that the frogs had been brought to Jamaica by Lady Blake during the incumbency of her husband, Sir Henry Blake, as Governor of Jamaica. This statement seems the more probable as the species has been very widely carried from island to island among the Lesser Antilles.

I think it doubtful whether the original habitat of this species will ever be known.

Hyla brunnea GOSSE.

Gosse, Nat. Sojourn in Jamaica, 1851, p. 361.

Heretofore it has been stated by Boulenger that both *Hyla ovata* (Cope) and *Hyla dominicensis* (Tschudi) occurred in Jamaica as well as in San Domingo. An examination of the type of *H. ovata* (M. C. Z., No. 1518), as well as other examples here and in the National Museum, convinced both Dr. Stejneger and myself that this species is a synonym of *H. dominicensis.* The types of this species came from San Domingo to the Paris Museum, taken by Mr. Alex. Ricord. The Jamaican tree frogs being different from the San Domingan ones, as a very large number show, it becomes necessary to use Gosse's name for these specimens. In all examples of *Hyla brunnea* the snout is abruptly truncate in profile, with the nostril near the apex. In *H. dominicensis* the nostril is much nearer to the eye, and the snout profile is a gentle slant-curve. This species also grows half as large again as *H. brunnea.* This Jamaican tree frog has also been confounded with and recorded as *H. septentrionalis,* which is a form quite distinct and not found in Jamaica.

The young of this species show a peculiar dichromatic condition. They may be generally dark in color, *i. e.* rather like the adults; or they may be light yellow, almost transparent, amber-like, with a broad white-edged, golden metallic band between the eyes. When I first took six or seven of these, I was convinced that they represented a new species, but the large series shows that this is not the case.

Gosse, *loc. cit.*, p. 358–361, has a number of interesting notes on tree frogs, remarking on the calls so often heard at night. He says that he is informed that the frogs spend their time sitting in the small amount of water held "by the large ventricose leaves of the greater wild pines, especially that fine one, *Tillandsia lingulata.*" This is quite true, and about Mandeville in an afternoon by cutting down bunches of these epiphytes and shaking them, more than thirty specimens were obtained. Mr. A. E. Wight took six examples from the wild pines near Port Antonio, and has since sent in others from Mandeville. The characteristic harsh grating snoring of this frog is heard all over the island where wild pines are abundant, *i. e.* at a slight elevation above sea level.

As with so many other West Indian forms, it becomes more and more certain, as extensive collections from the different islands are studied, that their distribution is not so wide-spread as many of the older writers have supposed. Neither do many closely related forms generally exist on one island. This very fact now so well proven rendered the record of three closely related Hylas from Jamaica as obviously suspicious; and these three species typical of other islands reduce themselves to one peculiar form. It may be noted here that the citation given by Boulenger to the original description of *Hyla dominicensis* Tschudi (Batr., 1838, p. 72) refers to a *nomen nudum*. The description is on page 30.

Hyla lichenata (GOSSE).

Trachycephalus lichenatus Gosse, Nat. Sojourn in Jamaica, 1851, p. 362, pl. 7.

Unfortunately I have been unable to examine a single specimen of this most strange creature. Neither this Museum nor the United States National Museum has a single example, and I have learned recently that the specimens which Cope reported were in the Museum of Amherst College have been discarded as too poorly preserved. Cope also recorded (Proc. Acad. Nat. Sci., Phila., 1863, p. 46–47) a specimen in the Smithsonian Collection, which has been lost. The species *Hyla anochlorus* (Gosse), redescribed by Cope (*loc. cit.*), was doubtless based on sexual characters of divergence only.

The species, which seems very rare, is known from Jamaica only.

Gonatodes albogularis (Dum. & Bibr.).

Boulenger, Cat. Lizards Brit. Mus., 1885, **1**, p. 59.
Gymnodactylus albogularis Dumeril et Bibron, Erp. Gén., **3**, 1836, p. 415.

I have three specimens from Kingston, kindly sent me by Dr. Boulenger, who writes that Mr. C. A. Wray recently took a number in wooden houses about that town. The species must be of very local distribution, as none of the collections accessible contain specimens. The British Museum had two Jamaican specimens when the catalogue was compiled. Dr. Duerden remarked that it was very rare and that the Museum of the Institute of Jamaica had never received a single example.

Occurs in Cuba and Jamaica; like other geckos, it may prove to be of wider fortuitous distribution. Perhaps, we might almost say probably, introduced into Kingston by the direct communication with Santiago de Cuba.

Aristelliger praesignis (HALLOWELL).

Hemidactylus praesignis Hallowell Proc. Acad. Nat. Sci. Phila., 1856, p. 222.

Another species which is generally wide-spread over the island. The natives have a peculiar fear of "the croaking lizard," and it is seldom that they can be persuaded to bring it in. Mr. Wight notes that it seems to be rare. This, however, is not the case. It is readily found when once one knows where to look for it: about the rafters of old buildings, in the wall crevices of the ruins of the many long-disused sugar factories, and in hollow trees. While hunting insects, its eggs are often found in crannies of bark, sticking to the wood and to each other in pairs. These eggs are found in the same places and are just the same size and are laid in the same way as those of Ptychozoon in the East Indies. Gosse (Nat. Sojourn in Jamaica, 1851, p. 184-185) discusses the egg laying, but there seems no reason to suppose that the period of incubation is the same as in Ptychozoon, where the eggs, as Annandale has shown, last over from one season and do not hatch till the next year. Good specimens are almost impossible to get. The skin of the neck and back is as delicate as damp tissue paper and tears as easily, while the tail is very frequently dropped. Fourteen specimens from near Kingston are before me. Mr. Wight's specimen is from near Port Antonio. The Museum has Jamaican specimens with no special data; also two from Cayman Brac, and three from Grand Cayman. From these two islands they were first made known in Garman's report on Maynard's collections. It would be curious if this lizard had not been found on this outlying dependency of Jamaica, when we think of the constant communication between the islands and the long-known frequency with which geckos are accidentally carried about. The type of *Aristelliger lar* Cope from Jeremie, Hayti, is nearly 14 inches long. This is five inches longer than any of our specimens of *A. praesignis*, and almost the same amount larger than the one which Boulenger had measured for the Catalogue. Series of embryos of this species were prepared for the Zoölogical Department of Harvard University and for the Embryological Department of its Medical School.

Known from Jamaica and the Cayman Islands.

Sphaerodactylus richardsonii Gray.

Gray, Cat. Lizards Brit. Mus., 1845, p. 168.
Gosse, Nat. Sojourn in Jamaica, 1851, p. 254.

The Museum of the Jamaica Institute before its destruction contained two specimens of this rather rare gecko. A specimen in the British Museum came from Montego Bay. The only other example there, the type, is without definite locality. I have three examples, all taken about Kingston. As with the other members of this family, this lizard is probably widely spread over the island, though its shy habits and apparent scarceness make it a little known member of the fauna. It seems to haunt the crevices in old rock walls, though I was informed that an individual had been seen under the thatching of the roof of an old house. This species does not lose its tail easily. It grows to a length of nearly four inches. Gosse during his long stay on the island met with only a single example; this was near Montego Bay. Perhaps this specimen is the one now in the British Museum, though Boulenger gives no data concerning it.

It is peculiar to the island.

Sphaerodactylus goniorhynchus Cope.

Cope, Proc. Acad. Nat. Sci. Phila., 1894, 1895, p. 440.

This species is not represented in any of the collections which have come to hand from Jamaica. The types were taken by the University of Pennsylvania West Indian Expedition of 1890 and 1891 at Port Antonio. There is a well-preserved example, No. 36648, in the United States National Museum.

Peculiar to Jamaica.

Sphaerodactylus oxyrhinus Gosse.

Gosse, Ann. Mag. Nat. Hist., 1850, ser. 2, **6**, p. 347.

It is very unfortunate that our collections throw no new light on the habits or distribution of this rare form. Dr. Duerden recorded, Kingston Daily Gleaner, that the Museum of the Institute of Jamaica had two specimens. A careful search failed to find them among the few reptiles still preserved there. They were probably destroyed by the earthquake or lost during the subsequent moving of the collections.

Boulenger records but one specimen in the British Museum, Gosse's type from St. Elizabeth (Cat. Liz. Brit. Mus., 1885, **1**, p. 222). There is also but a single specimen in the collections here, No. 7033, without more definite locality than Jamaica.

Sphaerodactylus gilvitorques Cope.

Cope, Proc. Acad. Nat. Sci. Phila., 1861, p. 500.

This gecko has been supposed to be most uncommon. Duerden states that no specimen ever reached the Institute collection. The same may be said of Boulenger (*loc. cit.*, p. 227), who did not know the species from autopsy. Eleven examples taken while searching for Peripatus near Bath, in eastern Jamaica, are before me. Most of these were taken deep among the roots of banana plants, where their eggs, scattered singly in the earth or decaying vegetable matter on the ground, were also found. This little lizard seems to be a rather good burrower. Three specimens came from Mandeville in middle Jamaica; they were caught under stones. Mr. A. E. Wight took several here and three more near Port Antonio. His field notes show that these also were taken under stones. He remarks on their activity and difficulty of capture, which is rather striking. This species is sometimes called "wood slave" or "little wood slave" by the natives, though more generally by the name mentioned for *S. argus.* The name of "wood slave" is a very old one, also occasionally applied to *Mabuia sloanii*, for which the name "snake-waiting boy" is now more common. Gosse mentions the former name.

The color is fairly variable. The collar is generally very inconspicuous, while the rather elaborate arrangement of lines on the head, described by Boulenger and Cope, is not at all a constant character. Generally speaking, all are rich mahogany brown above, with rhomboidal markings in reddish brown. These may be faint, but are almost always visible on the posterior part of the body. Below lighter, sometimes rather bluish or ashy gray, finely dotted with dark brown. The chin is often almost white with dark brown parallel lines in two series, which converge towards the middle of the back of the throat. A freshly hatched young one shows white marked rhombs and conspicuous white lines on the neck.

Found only on Jamaica, perhaps more common in higher altitudes, as in Mandeville and the hills about Bath. Though Wight's specimens came from lowlands about Port Antonio, not a single example was taken on the plain about Kingston.

Sphaerodactylus argus Gosse.

Gosse, Ann. Mag. Nat. Hist., 1850, ser. 2, 6, p. 347; Nat. Sojourn in Jamaica, 1851, p. 76, 284.

This is the commonest member of this genus over the part of Jamaica whence it is recorded. We took sixty-four specimens about Kingston and fifteen at Mandeville, where Mr. Wight has also taken it. A few years ago Major Wirt Robinson gave two examples to the Museum, also from near Kingston. Gosse took it in western Jamaica, and the Museum has one from Moneague. From the vicinity of Bath and Port Antonio and other stations near by, it seems to be quite certainly absent. Mr. Wight also failed to find it at Port Antonio.

The series from Kingston shows that this is perhaps the most variable species in the genus. This lizard may present a uniform pepper-and-salt appearance, or the white may appear in the typical ocelli on the back and top of the head, or the ocelli on the back with elongate spots on the neck and the head, or as white vittae. The white markings may be absent on any one region and present on another, thus making possible a large number of combinations in pattern. The lower surface of the tail is usually coral red in life. The color of the embryos just before leaving the egg seems to be of one pattern only. The six white bands sometimes seen on the heads and necks of adults here are very wide and conspicuous and extend from nose to root of tail. They are rather dark edged and the ground color is uniform slaty without the finely punctulate appearance of the ground color of the adult.

For all these small geckos one must search carefully in the cracks and crannies of old walls, under loose stones, and about thatched roofs. A pile of old thatching lying on the ground is certain to contain Sphaerodactyli if any occur in the neighborhood. The negroes in Jamaica, who can aid one tremendously in lizard hunting, call all of the genus "pawley" lizards or water lizards. The latter name is used about Mandeville, and no explanation was obtained as to its meaning.

The species is peculiar to Jamaica.

Sphaerodactylus dacnicolor, sp. nov.

Plate 1.

Types: two specimens (M. C. Z., No. 7276) collected at Port Antonio, Jamaica, by Mr. A. E. Wight.

Snout pointed and elongate, distance from tip of nose to eye greater than distance from latter to ear opening. Rostral large with a long median cleft. Nostril between rostral, first supralabial, one small triangular postnasal, and a moderate supranasal. The two supranasals and a small scale between them border the rostral above posteriorly. Four large supralabials to beneath center of eye Head and body covered with small, rather prominent, tubercle-like scales, larger on snout. Mental large, like rostral, in contact with two scales posteriorly. Two large and deep, one small and deep, and one small and narrow infralabials. Scales on throat imbricate, small, rounded in outline, sometimes with a trace of a keel. On the belly the scales are smooth with a more triangular outline.

Ground color of upper surfaces grayish or slightly reddish, with scattered spots of dusky gray. Some of these are of considerable size, much larger than in *S. punctatissimus* Dum. et Bibr., or in *S. nigropunctatus* Gray. Posterior to the sacral region is a spectacle-like marking similar to that often seen in *S. lineolatus* Lichtenstein var. B. Boulenger (Cat. Liz. Brit. Mus., 1885, **1**, p. 222).

Cyclura lophoma Gosse.

Gosse, Proc. Zool. Soc. Lond., 1848, pt. 16, p. 99–104, pl. 1.
Gosse, Nat. Sojourn in Jamaica, 1851, p. 76–77.

We did not succeed in securing a specimen of the Iguana. It is reported to be still extant in the range of highlands known as the Heathshire Hills, but to be very rare. It is absent from the rest of the main island. Dr. M. Grabham, the well-informed naturalist of Kingston, to whom I am indebted for many valuable notes, tells me that a small colony still exists on Goat Island. This is a good-sized piece of land, whither happily the mongoose has not been carried and where probably the last of the iguanas and boas will be found. Goat Island lies in Portland Bight, off the south coast of Jamaica, not far from Old Harbor and the mouth of Salt River.

Until some one studies material from all the islands on which iguanas occur, so that the exact identity and distribution of each species can be made out, it is impossible even to conjecture the range of all the species. This one, to judge from descriptions only, seems to be confined to Jamaica.

Xiphocercus valenciennesii (Dum. & Bibr.).

Anolis valencienni Dumeril et Bibron, Erp. Gén., 1837, **4**, p. 131.
Placopsis ocellata Gosse, Nat. Sojourn in Jamaica, 1851, p. 226–227.

This lizard, which is commonly known to the natives as "the white croaking lizard with red gills," is everywhere very uncommon. Three specimens were taken at Constant Springs, near Kingston, and one at the Castleton Botanical Gardens. The species is known to the natives in the vicinity of Spanish Town and Mandeville. From the latter locality Mr. Wight has recently sent in seven fine examples. At Bath, and at other points in the eastern part of the island, as well as at Port Antonio, it was not known to the natives, so far as I could find out. There is a specimen in the collection of the Museum, No. 6232, from Kingston. The life colors of this creature are rather attractive. It is gray or whitish green varied with dark lines and narrow points of brown. The body is often reddish below. The dewlap is a splendid rich claret color. As one sees it clinging to the bark of a tree, the resemblance to a lichen is most striking. It is not so quick in trying to escape as most of the other forms and is ready to bite viciously. The natives consider it the most poisonous lizard on the island.

Gosse reports having seen only three specimens during his stay in Jamaica. He mentions no special locality, but page 226 of "A Naturalist's Sojourn in Jamaica" is headed "Kingston," and they probably came from there.

The species is peculiar to Jamaica.

The Jamaican Anoles resolve themselves into six species, of which five are peculiar to Jamaica. *Anolis garmanii* Stejneger is the largest, most easily identified, and the most widely distributed. *Anolis lineatopus* Gray is perhaps the most abundant lizard on the island, though its range is peculiarly circumscribed. *Anolis sagrae* Dum. et Bibr. is found sparingly and, of course, is a wide-ranging species. Three species are very closely related and extremely difficult to distinguish *inter se*, viz., *Anolis opalinus* Gosse, *A. iodurus* Gosse, *A. grahamii* Gray.

Anolis garmani Stejneger.

Stejneger, Amer. Nat. 1899, **33**, p. 602.
Dactyloa edwardsii Gosse, Nat. Sojourn in Jamaica, 1851, p. 76, 142–145, pl. 4.

This beautiful vivid green lizard is perhaps the most widely distributed, though by no means the most common of its genus on the island. I have before me specimens from near Kingston, Mandeville, Port Antonio, Buff Bay, and Bath, and my notes show that I observed it almost all over the island. The description given by Boulenger in his Catalogue of the lizards of the British Museum describes the colors very well. The species seems to change rather less than the others during life, though the vivid green may become a dull brown. The color of the dewlap is light orange. It is found often at the base of the leaves of palm trees, where its color protects it very well. I never saw one of these lizards within ten feet of the ground. Gosse writes that it seems to affect the higher mountain woods. It seems now, however, to be as common at lower levels. Gosse also notes that the food consists of insects and vegetable substances. My observations substantiate this statement.

This species is known only from Jamaica.

Anolis lineatopus Gray.

Gray, Ann. Mag. Nat. Hist. 1840, **5**, p. 113.
Boulenger, Cat. Lizards Brit. Mus. 1885, **2**, p. 39–40, pl. 1, figs. 1–2.

The zebra lizard is excessively common on the coastal plain about Kingston and Spanish Town. When riding along the Constant Spring Road, it was often noted that about eight out of ten fence posts or trees passed had from one to four of these lizards upon it. They became, however, uncommon when the road passed into the woods. Continuing across the island to the north shore not a single specimen was seen after the ridge was crossed, and at Castleton Gardens on the north side of this divide a careful search failed to reveal a single example. In the material at hand are about a hundred or more examples taken within a mile of the Constant Spring Hotel. They are equally abundant about the outskirts of Spanish Town; but at Mandeville not a single example was found.

Anolis sagrae Dum. & Bibr.

Dumeril et Bibron, Erp. Gén., 1837, 4, p. 149.

Apparently rare. There are three specimens in the United States National Museum from Jamaica with no definite locality; and one in the collection of the M. C. Z., obtained from the U. S. Nat. Mus. in exchange. In my collection, or in that made by Mr. A. E. Wight, not a single example occurs. In my notebook I find record of catching what I took to be *Anolis sagrae* at Anotto Bay, but the specimen is evidently lost. In coloration I do not believe that this lizard can be distinguished from *A. lineatopus*, but the larger head shields, the more even sized and more strongly keeled ventrals serve to separate specimens in hand easily. A comparison of the four specimens with Cuban and Bahaman specimens shows no difference between them.

This lizard ranges through the Bahamas to Cuba, Jamaica, and part of Central America also; according to Boulenger, to Venezuela.

Anolis iodurus Gosse.

Gosse, Ann. Mag. Nat. Hist., 1850, ser, 2, 6, p. 344.

Dr. Stejneger, who has very kindly aided me in the study of these lizards, has shown me that the species usually called *A. grahamii* Gray has been confounded with *A. iodurus.* Gosse states that the ventral scales are smooth, while Gray states that in his species the ventrals are keeled. This species is the vivid green species with sky-blue tail which is found about Kingston and other localities in middle Jamaica, as in Hope and Castleton Gardens, at Anotto Bay and about Spanish Town and Bog Walk. The dewlap is very widely distensible and is a burnt orange color with a deeper red center. It changes to brown or almost black, and when it does so, faint vermiculations appear like those which so strongly mark *A. opalinus* and the true *A. grahamii.* Usually, however, it is solid leaf green and is, in life, very easily distinguishable from these other two species. In the young there is often a wide white vertebral band, and this is sometimes visible in examples about half grown. In three specimens from Mandeville there is a strong tendency toward an imbrication of the smooth ventrals; this is also marked in some of the series of about twenty from Kingston; it is more or less evident in all.

Confined to Jamaica.

Anolis opalinus Gosse.

Gosse, Ann. Mag. Nat. Hist. 1850, ser. 2, **6**, p. 345.

This species is apparently confined to the western part of the island. The United States National Museum has two specimens from Moneague. Gosse's specimens came from about Bluefields. There are fifteen from Mandeville at hand. Stejneger felt some doubt as to whether these really represented Gosse's *A opalinus* because of the small numbers in the collections. Gosse states that this and *A. iodurus* are the commonest lizards in the parishes of St. Elizabeth and Westmoreland. Now these parishes are not very thickly populated and contain no large towns, consequently I presume that the mongoose has had an even freer hand thereabouts than elsewhere. As for the abundance of the species under discussion about Mandeville, I can say that undoubtedly twenty-five specimens could be taken in any walk of a couple of hours, though it must be admitted that here again the lizards are rarer a little distance out of town than near it or even in the town itself.

This species is easily distinguished in life. The green phase does not show a solid color, but strong, well-marked vermiculations of a light color — almost white. Along each side there is generally a broad light band. In the brown condition the markings on the body are as evident; the tail is usually brown. The smooth plate-like ventral scales which show no tendency to imbricate and which are rather irregular in form and size, distinguish spirit specimens from *A. iodurus*. In life the almost always present white lateral stripe serves as a field mark for distinction from the solid green-bodied and sky-blue-tailed *A. iodurus*. In the former species the dewlap is different from that of the latter. It is pink with usually a light, almost white, edge.

Also confined to Jamaica.

Anolis grahamii Gray.

Gray, Cat. Lizards Brit. Mus., 1845, p. 247.

Though in the field this lizard is practically impossible to distinguish from the preceding species of small green lizard, it is very easily separated when the specimen is in hand. The ventrals are inclined to imbricate and have a heavy swollen keel. At Bath, Port Antonio, and about Mandeville we took a considerable series of this species, and the variation in color was remarkable. Some were green with the tail hardly less blue than those so characteristic of *A. iodurus*, while others were dotted and marbled with the light color on a dark dull field identical with *A. opalinus*, except that the white lateral stripe was never a wide band but only suggested. This species represents beyond doubt what Cope (Proc. Acad. Nat. Sci., Phila., 1894) called *Anolis flabellatus*. Port Antonio was the type locality for this synonymous form. Generally speaking, this lizard seemed rarer than either of the former two.

Confined to Jamaica.

The name Celestus is used here for the three members of the Anguidae, each peculiar to Jamaica. The absence of an ungual sheath into which the claws may be retracted is a character of generic value, as opposed to the presence of the sheath in the true Diploglossi.

The anguids of Jamaica have been described under a number of names, each purporting to represent a distinct species. In the pages that follow, their number has been reduced to three. It is extremely improbable that there are more forms than this in an area the size of Jamaica. They probably at one time occurred all over the island, though they are now, owing to mongoose ravages, of sparse occurrence in highlands only. The occurrence of all three species in Mandeville is good proof that there was never any localized distribution for Celesti such as now exists among the Anoles.

To find the former in any numbers it is necessary to get a number of men at work moving all possible loose stones. Pulling down stone walls is a very probable means of finding them. They are quick in trying to escape, and when taken in the hand they bite fiercely and struggle so that it is difficult to keep the tail and squamation undamaged. An open, wide-mouthed bottle of spirits should be immediately at hand.

The following quotation from page 77 of the "Naturalist's Sojourn in Jamaica" is all Gosse has to say of Celestus. "In the swamps and morasses of Westmoreland, the yellow Galliwasp (*Celestus occiduus*), so much dreaded and abhorred, yet without reason, might be observed sitting idly in the mouth of its burrow, or feeding on the wild fruits and marshy plants which constitute its food." From the stomach of one of this genus isopods and cockroaches were taken and also what I took to be remains of freshly devoured earthworms.

Celestus occiduus (Shaw).

Lacerta occidua Shaw, Zoology, 1802, **3**, p. 288.
Diploglossus occiduus Shaw, Boulenger, Cat. Lizards Brit. Mus., 1885, **2**, p. 290.
D. striatus Gray, Boulenger, Cat. Lizards Brit. Mus., 1885, **2**, p. 289.
D. hewardii Gray, Boulenger, Cat. Lizards Brit. Mus., 1885, **2**, p. 291, pl. 17.

There can be, I think, no doubt whatever that the species Shaw described is a rather variable one characterized by its scales being both keeled and striate, which must include the other species mentioned above. Three specimens taken in Mandeville, Jamaica, show that size is valueless as a means of separation. Scale rows then vary from 40 to 56, and the colorations include the phases which Boulenger has described for his three separate species, and one remains to be added, viz., rich red brown, with longitudinal black comma-like marks on the back, and white spots on the sides. Sides of neck black; the black area divided into squares by white lines.

This, the largest and most conspicuous member of the genus in Jamaica, has been the one which heretofore has come most often to herpetological collections. It is now, however, very rare, the mongoose being without doubt responsible for its reduction in numbers.

Celestus crusculus (Garman).

Diploglossus crusculus Garman, Bull. Essex Inst., 1887, **19**, p. 22.
Diploglossus bakeri Boulenger, Ann. Mag. Nat. Hist., 1900, ser. 7, **6**, p. 193.

This, the Celestus with striate but non-carinate scales, is less common about Mandeville, Jamaica, than the smooth-scaled *C. impressus*, and more abundant than the keeled-scaled *C. occiduus*. With Garman's type from Kingston (M. C. Z., No. 6051) before me, there is no doubt that *D. bakeri* Boulenger is identical. The color of the type is now somewhat faded, but it is evident that originally it agreed exactly with the color Boulenger has so accurately described. Six specimens which I procured near Mandeville and three which Mr. Wight has sent in also agree with Boulenger's description. In these fresh specimens the bellies of the males are a brilliant salmon pink. The scale rows are variable in number; records give from 38 to 50.

Celestus impressus Cope.

Cope, Proc. Acad. Nat. Sci. Phila., 1868, p. 127.

This is the most common member of the genus about Mandeville, Jamaica. I obtained twenty-one specimens, and Mr. A. E. Wight two. The scales are smooth. Cope's type was undoubtedly a dried and shrunken specimen. This accounts for the "dorsals with a cross elevation and marginal depression making rows of pits." The narrow brown bars, from eighteen to twenty in number, which are broken and alternate at the median line, serve to distinguish this from the other two Jamaican species of Celestus. The type of *Celestus maculatus* (Garman) from Cayman Brac (M. C. Z., No. 6231), is closely related to this species. It is, I think, undoubtedly distinct and can be distinguished by the broad dark lateral band running through the eye along the side to the hind limb. The coloration of the twenty-three Jamaican examples studied is typical and unvarying.

Ameiva dorsalis Gray.

Gray, Ann. Nat. Hist., 1838, **1**, p. 277.
Gosse, Nat. Sojourn in Jamaica, 1851, p. 74.

Perhaps no lizard in Jamaica has suffered more from the ravages of the mongoose than this one has. Dr. J. E. Duerden wrote in the Daily Gleaner of 1896, that it had been almost exterminated but was beginning to reappear more commonly near the town. Now, while this lizard is an especially shy one, it seems fairly common in hot sunny pasture lots near the city of Kingston. It has probably grown more common as the mongoose has grown scarce, owing to the latter's being frequently killed in thickly settled communities, where it is a great robber of hen roosts. This lizard was reported by Gosse as very abundant. It is known to the natives by the name of "ground lizard" in most localities where open cleared land occurs extensively. We did not succeed, however, in obtaining specimens anywhere but about Kingston, where we took twelve.

It is known only from Jamaica.

Mabuia sloanii (DAUDIN).

Scincus sloanii Daudin, Reptiles, 1804, **4**, p. 287, pl. 55, fig. 2.
Mabouya agilis Gosse, Nat. Sojourn in Jamaica, 1851, p. 75.

This little skink, which is known to the negroes by the quaint name of "snake-waiting boy," is now one of the rarer members of the island fauna. Along with the other ground-inhabiting creatures of the lowlands near the coast this has been preyed upon extensively by the mongoose. About Kingston we procured three examples, and these were the only ones seen during our stay on the island. They seem to replace the so-called "galliwasps" (Celesti) in the lowland areas. Indeed, the negroes about Kingston have noticed this, and I was told that in the vicinity of the town there were no "galliwasps," while in the highlands, where they were found, one did not get the skink. The native name is given them because of the supposition that they follow snakes, as the jackal is often spoken of as the lion's follower.

Gosse reports the species as abundant, while Duerden in the Gleaner wrote, "Now occasionally found about Kingston."

Boulenger has tersely stated the distribution of this form as "West Indies south of 20°." This area, however, includes the ranges of several distinct but imperfectly known species. This form is doubtless confined to Jamaica.

Typhlops lumbricalis (LINNÉ).

Anguis lumbricalis Linné, Syst. Nat., ed. 10, 1758, **1**, p. 228.
Typhlops lumbricalis Gosse, Nat. Sojourn in Jamaica, 1851, p. 262–267.

This species is one spread generally over the island, though owing to its burrowing habits it is not often seen except by lifting rocks. Nearly all of the fifteen examples we took were under stones at Bath, Mandeville, and near Kingston. Mr. A. E. Wight has sent eight specimens, all from near the mouth of Bog River, in the vicinity of Port Antonio, northeast Jamaica. His field notes show that he caught one of these just as it was crawling into an old stone wall. Gosse records finding the eggs in the nests of Termites, a habit, then, which this species has in common with a number of African congeners.

Its range geographically extends from Abaco Island in the northern Bahamas, through the Antillean groups to British Guiana.

Tropidophis maculata (BIBRON).

Leionotus maculatus Bibron, Sagra's Hist. Cuba, Reptiles, 1843, p. 212, pl. 24.
Leionotus maculatus Gosse, Nat. Sojourn in Jamaica, 1851, p. 324–325.

A single typical example taken near Kingston is the only specimen of this species which is at hand. As Boulenger's descriptions (Cat. Snakes Brit. Mus., 1893, **1**, p. 112, 113) show, this form, the only one known from Jamaica, is easily distinguished from the Cuban (*T. pardalis* Gundlach) by having a larger number of ventrals. The coloration is variable enough in *T. pardalis* (Gund.) to bring it very close to that of *T. maculata* (Bibr.).

The single specimen was found tightly coiled up under a flat rock. Nothing notable is known of its habits.

In this genus material is insufficient to define the range of this form.

Epicrates subflavus Stejneger.

Stejneger, Proc. U. S. Nat. Mus., 1901, **23**, p. 469–470.

The Jamaica boa is so nearly extinct that it is now rarely captured. It still exists, I am told, on Goat Island off the southern coast of Jamaica in considerable abundance. There are no specimens in the collection here, though the United States National Museum in Washington possesses several examples.

The species, recently separated from *E. inornatus* Reinhardt, has been fully discussed in connection with the original description.

Leimadophis ater (Gosse).

Natrix atra Gosse, Nat. Sojourn in Jamaica, 1851, p. 228.
Dromicus ater Boulenger, Cat. Snakes Brit. Mus., 1894, **2**, p. 121.

The name Leimadophis (Fitzinger, 1843) is used for this and the following Jamaican snake, according to the distinction which Stejneger (Herpt. of Porto Rico, 1904, p. 694–695) has drawn between the two genera of coronelline snakes occurring in Porto Rico. The other genus, Alsophis (Fitzinger, 1843), is not found in Jamaica.

The absence of distinct pairs of pores near the apices of the dorsal scales fixes these two forms in this genus. This species may be easily distinguished by the absence of loreal shield and the following scale count: scales in 17 rows; ventrals 170–185; subcaudals 144–162. Compare these counts with those given for *L. callilaemus* (Gosse).

It is now extremely rare, and not a single example was taken. In the collection there are three (Mus. Comp. Zoöl., Nos. 6007, 1 ex.; 6005, 2 ex.), all from near Kingston. James Gall collector. The National Museum in Washington has four, Nos. 7375, 7332, 12364, labeled Jamaica; No. 5093 is marked "Cuba," but was taken by Mr. C. Wright, who collected in Jamaica. It is typical of this species, and without doubt the label is wrongly marked.

Confined to the island.

Leimadophis callilaemus (Gosse).

Natrix callilaema Gosse, Nat. Sojourn in Jamaica, 1851, p. 384–385.
Liophis callilaemus Boulenger, Cat. Snakes Brit. Mus., 1894, **2**, p. 142–143.

This species may be distinguished from the one previously mentioned by the following characters. A smaller adult size, the presence of a small square loreal shield, and the following scale formula: scale rows 17 or 19 (regularly the latter); ventrals 130–151, subcaudals 170–110. This form, which previously has seemed far rarer in collections than *L. ater*, is now not uncommon in some localities. The writer took fourteen near Kingston, and Mr. Wight has collected two in Mandeville and three in Port Antonio. From the two latter stations the specimens are olive or dark brown, the markings rather indistinct. All the Kingston specimens are red when adult with scattered marks on the sides of the head and throat. The young have a blackish stripe along the body and are spotted with dark brown. The throat and head are heavily marked with brown. The ground color, however, is the same as in the full-grown examples, viz., brick red.

Also confined to Jamaica.

Pseudemys palustris (Gmelin).

Testudo palustris Gmelin, Syst. Nat., 1788, **1**, part 3, p. 1041.
Stejneger, Rept. U. S. Nat. Mus. for 1902, 1904, p. 710–714.

Unfortunately only a single example from this island, which is the type locality, has come to hand. It was taken near Port Antonio, Jamaica. So poorly preserved that none of the markings on the head or limbs are distinctly visible, it does not throw any light on the possible existence of local races of this species on the different islands. I agree with Dr. Stejneger in anticipating these.

Turtles were seen in small ponds in various parts of the island, but they were so excessively shy that it was impossible to catch any.

Known from Jamaica, Haiti, Porto Rico, and Cuba.

Crocodilus americanus Laur.

Laurenti, Syn. Rept., 1768, p. 54.
Boulenger, Cat. Chelonians, etc., Brit. Mus., 1889, p. 281.

Crocodiles, hideously stuffed, are offered as souvenirs to tourists in the "curiosity shops" of Kingston. They seem to represent this species only. The natives state that there are still a number of localities about the island where crocodiles are abundant. All agree that they may be taken at the mouth of Milk and Black Rivers and in many other less important creeks emptying to the south and east. There are five small specimens in the collection of this Museum, taken many years ago near Kingston.

Ranges over Pacific coast region of Ecuador; Central America, Mexico, Cuba, Jamaica, and Florida.

PLATE 1.

Dorsal view of type of *Sphaerodactylus dacnicolor*, sp. nov. × 3.

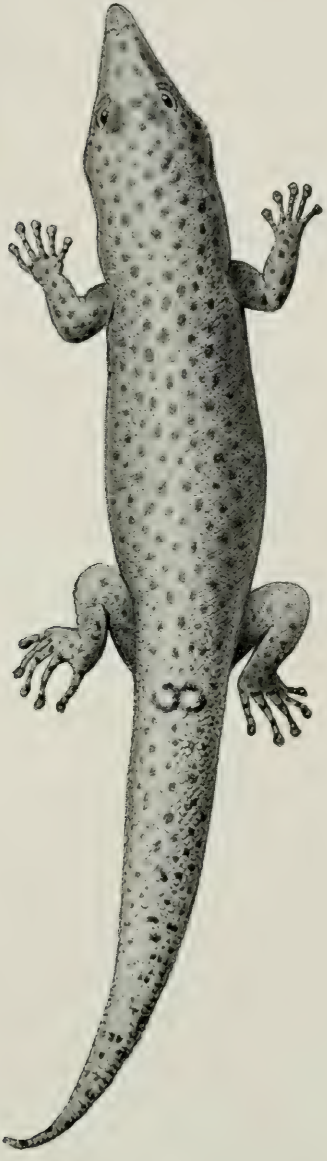
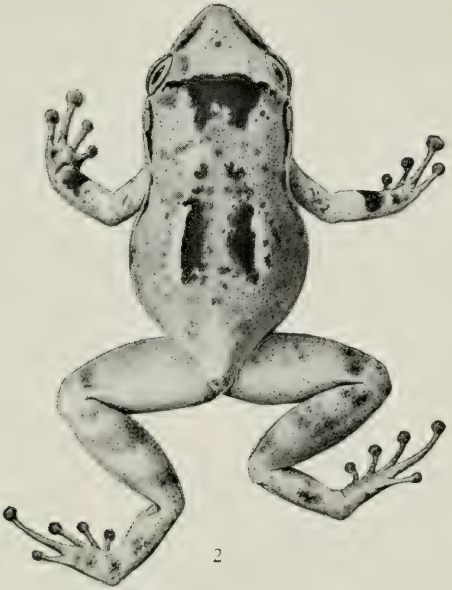


PLATE 2.

Fig. 1. Dorsal view of type of *Eleutherodactylus jamaicensis*, sp. nov. × 2.

Fig. 2. Dorsal view of specimen of *Eleutherodactylus luteolus* Gosse. To show dark phase of coloration.



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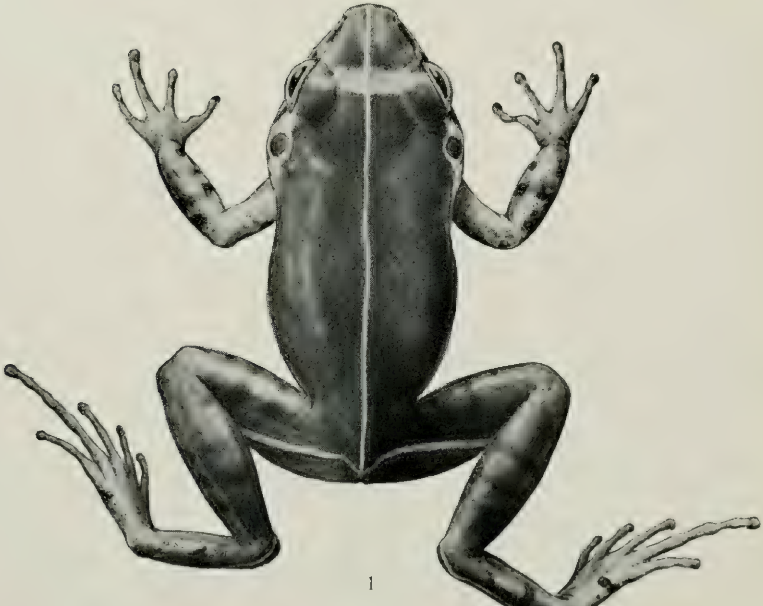

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LII. No. 16.

DECAPOD CRUSTACEANS COLLECTED IN DUTCH EAST INDIA AND ELSEWHERE BY MR. THOMAS BARBOUR IN 1906-1907.

By Mary J. Rathbun.

With Six Plates.

CAMBRIDGE, MASS., U. S. A.:
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September, 1910.

No. 16. — *Decapod Crustaceans collected in Dutch East India and elsewhere by Mr. Thomas Barbour in 1906–1907.* By MARY J. RATHBUN.

All the species noted were collected in the Dutch East Indian islands except three of the Potamonidae and one Bithynis from the fresh waters of northern India and the rare *Thaumastocheles zaleucus* from deep water off Japan, which was acquired through Mr. Alan Owston. Other species little known in collections are *Utica nausithoe* and *Macrophthalmus definitus.* Despite the extensive explorations by the Dutch in Java, Mr. Barbour's collection yields an undescribed species of potamonid from Buitenzorg which represents a new type of the subgenus Parathelphusa.

CALAPPIDAE.

Matuta lunaris (FORSKÅL).

Matuta victor Alcock, Journ. Asiat. Soc. Bengal, 1896, **65**, p. 160.

Celebes: Makassar; 1 ♂.

INACHIDAE.

Paramicippa platipes (RÜPPELL).

Paramicippa platipes de Man, Arch. f. Naturg., 1887, **53**, pt. 1, p. 227.

Moluccas: Amboyna; 1 small ♂.

OCYPODIDAE.

Ocypode ceratophthalma (PALLAS).

Ocypoda ceratophthalma Alcock, *op. cit.*, 1900, **69**, p. 345.

Moluccas: Galela, Halmaheira Island; 7 juv.

Lombok: Ampenan; 4 juv. In the largest specimen the stridulating ridge is undeveloped.

Uca annulipes (MILNE EDWARDS).

Gelasimus annulipes Alcock, *op. cit.*, 1900, **69**, p. 353, not *Gelasimus perplexus* Milne Edwards.

Celebes: Makassar, from mangrove swamp; 34 ♂ 4 ♀.

Uca perplexa (Milne Edwards).

Plate 1, figs. 1–2.

Gelasimus perplexus Milne Edwards, Ann. Sci. Nat. Zoöl., 1852 (3), **18**, p. 150 [114], pl. 4, figs. 18, 18*a*.

Moluccas: Wahaai, Ceram Island, in mangrove swamp; 2 ♂.
Celebes: Makassar; one claw.

Compared with specimens from New Caledonia, determined by A. Milne Edwards.

Uca gaimardi (Milne Edwards).

Gelasimus gaimardi Milne Edwards, Ann. Sci. Nat. Zoöl., 1852 (3), **18**, p. 150 [114], pl. 4, figs. 17, 17*a* (*gaimardii*).

Moluccas: Gane, Halmaheira Island, on land; 1 ♂ 1 ♀.
Moluccas: Amboyna; 1 ♀ very young; some doubt as to determination.

Uca tetragonon (Herbst).

Gelasimus tetragonum Alcock, *op. cit.*, 1900, **69**, p. 357.

Moluccas: Wahaai, Ceram Island, from mangrove swamp; 1 ♂.

Uca marionis (Desmarest).

Gelasimus marionis Alcock, *op. cit.*, 1900, **69**, p. 359.

Celebes: Makassar; 5 ♂ 2 ♀.
Moluccas: Wahaai, Ceram Island, mangrove swamp; 6 ♂.

Uca coarctata (Milne Edwards).

Gelasimus coarctatus Milne Edwards, Ann. Sci. Nat. Zoöl., 1852 (3), **18**, p. 146 [110], pl. 3, fig. 6.

Celebes: Makassar, mangrove swamp; 2 ♂ 1 ♀.

Uca dussumieri (Milne Edwards).

Gelasimus dussumieri Alcock, *op. cit.*, 1900, **69**, p. 361.

Celebes: Makassar, mangrove swamp; 1 ♂.

Uca urvillei (Milne Edwards).

Gelasimus urvillei Alcock, *op. cit.*, 1900, **69**, p. 362.

Moluccas: Wahaai, Ceram Island, in mangrove swamp; 1 ♀.

Macrophthalmus latreillei (Milne Edwards).

Macrophthalmus latreillei Laurie, Ceylon Pearl Oyster report, Brachyura, 1906, p. 427, pl. 2, fig. 3, text fig. 12.

Celebes: Makassar; 1 ♂.

Macrophthalmus pacificus Dana.

Plate 1, fig. 3.

Macrophthalmus pacificus de Man, Notes Leyden Mus., 1890, **12**, p. 70, pl. 4, fig. 10.

Moluccas: Amboyna; 2 ♂ 2 ♀ 1 juv. The "two minutely granulated, pubescent, longitudinal lines," described by de Man as running parallel with each other not far from the postero-lateral margins, are scarcely distinguishable in these specimens. The central part of the carapace is smooth (non-granulate). The arcuate edge of the front has a tendency to bilobe.

Macrophthalmus definitus Adams and White.

Plate 2, fig. 1.

Macrophthalmus definitus Ortmann, Zool. Jahrb. Syst., 1897, **10**, p. 342.

Celebes: Makassar; 1 ♀. Compared with specimens from the Philippines in the Museum of the Academy of Natural Sciences of Philadelphia,[1] and determined by Dr. Ortmann (*loc. cit.*).

The general aspect is much the same as in *M. japonicus*,[2] but the following differences are observed: The carapace is decidedly narrower in *definitus*, its length $\frac{3}{4}$ of its greatest width (in *japonicus*, length about $\frac{2}{3}$ greatest width); a granulated line several granules in width and concave forward, on each epigastric lobe; the smooth areas of the dorsal surface are well defined, that on the gastric region has somewhat the form of a clover leaf, those on the hepatic region and at the antero-internal angle of the branchial region are subtriangular; that on the cardiac and intestinal regions is mushroom-shaped; the front between the eyes is less constricted or hourglass-shaped.

The cheliped of the male is considerably larger in *M. definitus*, specimens of a size compared. The lower surface of the arm is devoid of the thick mat of long hair that exists in *M. japonicus;* the outer surface of the palm is rolled over inward at its proximal end more strongly; upper edge of the palm blunt and coarsely granulate, with no line of single granules (in *japonicus* there are two rather well-defined lines of granules, those of the inner line larger and sharper than those of the outer; also on the inner surface a little below the upper edge, an incomplete line of granules coarser than the others on the inner surface); the greater part of the inner surface of the palm as well as the inner surface of the fingers is covered with long hair. In both species there is a squarish, truncate tooth near the base of the dactyl, but it is very much smaller in *M. definitus;* the low, oblique tooth on the immovable finger is situated near its middle in *definitus*, but is not far from the proximal end in *japonicus*, so that the teeth of the opposing fingers strike each other in *japonicus*, but are widely separated in *definitus*. Chelipeds of female similar in the two species. Legs narrower in *definitus*, merus joints

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[1] Through the kindness of Mr. Witmer Stone.

[2] De Haan, Fauna Japon., 1835, p. 54, pl. 7, fig. 1 (♀), pl. 15, fig. 2 (♂).

of second and third pairs narrowing more at the distal end; distal spine smaller, slenderer; legs of second and third pairs more pubescent and hairy. In *definitus* the third abdominal segment of the male, and the second and third of the female, are crossed by a transverse ridge, lacking in *japonicus;* each of the segments in the male, except the second and seventh, is longer in proportion to its width than in *japonicus.*

Dimensions. — ♂, Philippines: length 23.2 mm., greatest width (posteriorly) 30 mm., width at antero-lateral angles 27.8 mm.

♀, Makassar: length 19.6 mm., greatest width (posteriorly) 25 mm., width at antero-lateral angles 22.2 mm.

GRAPSIDAE.

Grapsus grapsus tenuicrustatus (Herbst).

Grapsus grapsus tenuicrustatus Rathbun, Bull. Bur. Fisheries for 1903, 1906, part 3, p. 838.

Dutch New Guinea: Sorong; 1 mature ♀ with a large Rhizocephalid filling the abdomen.

Moluccas: eastern part of harbor of Tifou, Bourou Island, 1 ♀.

Metopograpsus latifrons (White).

Metopograpsus latifrons Milne Edwards, Ann. Sci. Nat. Zoöl., 1853 (3), **20**, p. 166 [132].

Dutch New Guinea: Sorong; 1 ♂ 1 ♀ ovigerous.

Utica nausithoe de Man.

Plate 2, figs. 2-3.

Utica nausithoe de Man, Zool. Jahrb. Syst., 1895, **9**, p. 113, pl. 28, figs. 24-24c (Atjeh).

Bali: Boeleleng; 1 ♂. Length 25.2 mm.; width 27 mm. The posterior foot is considerably shorter than the others, not reaching beyond the middle of the propodus of the preceding pair.

Metasesarma rousseauxi Milne Edwards.

Metasesarma rousseauxii Alcock, *op. cit.*, 1900, **69**, p. 427.

Moluccas: Patani, Halmaheira Island; 1 ♂ 4 ♀.
Dutch New Guinea: Saonek, Waigiu Island; 1 ♂ juv.
Dutch New Guinea: Manokwari, beach; 2 ♂.

Metasesarma aubryi A. Milne Edwards.

Sesarma (Metasesarma) aubryi de Man, Zool. Jahrb. Syst., 1895, **9**, p. 130; 1898, **10**, pl. 29, fig. 27.

Moluccas: Patani, Halmaheira Island; 2 ♂.
Dutch New Guinea: Sorong; 1 ♀.
Dutch New Guinea: Manokwari, beach; 1 ♂ 1 ♀.

Sesarma (Sesarma) noduliferum DE MAN.

Sesarma (*Geosesarma*) *nodulifera* de Man, in Weber, Zool. Ergeb. Niederl. Ost-Indien, 1892, **2**, p. 342, pl. 20, fig. 16.

Java: Buitenzorg; 2 ♂.

Sesarma (Sesarma) sylvicola DE MAN.

Sesarma (*Sesarma*) *sylvicola* de Man, in Weber, Zool. Ergeb. Niederl. Ost-Indien, 1892, **2**, p. 345, pl. 20, fig. 18.

Java: from stream on Mt. Papangdaiang, Garoet; 1 ♀.

Sesarma (Sesarma) gracilipes MILNE EDWARDS.

Plate 3, figs. 1–2.

Sesarma (*Sesarma*) *gracilipes* de Man, Abh. Senckenb. naturf. Ges., 1902, **25**, heft **3**, 1902, p. 507, pl. 19, fig. 7.

Dutch New Guinea: Manokwari; 1 ♂. Carapace 17 mm. long, 17.8 mm. wide. The lateral teeth are unmistakable; they are obtuse angled and scarcely project sideways one beyond the other, but are elevated each above the preceding; they are further accented by a dark spot on the otherwise light-colored margin. The dactyli of the legs taper very little up to the horny tips; the posterior margin is nearly straight.

Sesarma (Chiromantes) bidens (DE HAAN).

Sesarma bidens Alcock, *op. cit.*, 1900, **69**, p. 415.

Moluccas: Gane, Halmaheira Island; 1 ♂.

Sesarma (Parasesarma) plicatum (LATREILLE).

Sesarma quadratum Alcock, *op. cit.*, 1900, **69**, p. 413.

Celebes: Makassar, mangrove swamp; 1 ♂.

Sesarma (Parasesarma) leptosoma HILGENDORF, VAR.

Plate 4, fig. 1.

Sesarma leptosoma de Man, Zool. Jahrb. Syst., 1889, **4**, p. 436, pl. 10, fig. 11.

Dutch New Guinea: Pom, Jobi Island; 1 adult ♀. This specimen differs from de Man's description and figure in having even more slender legs. In the third pair of ambulatories, the propodus measures 7.8 mm. on its anterior margin, and 1.6 mm. in its greatest width; dactylus 3.2 mm. long.

Zanzibar (Hilgendorf); Bagamoyo (Pfeffer); Fiji Islands (de Man, Ortmann).

Plagusia immaculata Lamarck.

Plagusia immaculata de Man, Arch. f. Naturg., 1887, **53**, Bd. 1, p. 371.

Dutch New Guinea: Sorong; 1 juv.

XANTHIDAE.

Carpilius convexus (Forskål).

Carpilius convexus Alcock, *op. cit.*, 1898, **67**, p. 80.

Moluccas: Amboyna; 1 juv.

Atergatis ocyroe (Herbst).

Atergatis floridus Alcock, *op. cit.*, 1898, **67**, p. 98.

Moluccas: Amboyna; 1 ♂.

Leptodius exaratus (Milne Edwards), var.

Xantho (*Leptodius*) *exaratus* Alcock, *op. cit.*, 1898, **67**, p. 118.

Moluccas: Amboyna; 2 ♀, 1 ovigerous, 5.2 × 7.9 mm. These are not typical *exaratus*, but approach Stimpson's var. *f*, *acutidens*.[1] The carapace is well areolated and coarsely granulated, the lateral teeth thickened, especially at the tips, but not so prominent as in var. *acutidens*.

Eriphia scabricula Dana.

Eriphia scabricula Alcock, *op. cit.*, 1898, **67**, p. 216.

Moluccas: Amboyna; 1 ♀, with rhizocephalid parasite.

POTAMONIDAE.

Potamon (Potamon) granulatus (de Man).

Plate 4, fig. 2.

Potamon (*Potamon*) *granulatus* Rathbun, Nouv. Arch. Mus. Hist. Nat., 1904 (4), **6**, p. 274.

Java: Tjibureum, at 5200 feet elevation; 1 ♂, dried.

Length 38.2 mm., width 50 mm., width between the outer angles of the orbit 31.7 mm., width across lower edge of front 12.5 mm. This is the largest specimen yet taken. By comparison with the figures by de Man,[2] it is seen to be more swollen laterally at the branchial regions, and relatively narrower across front and orbits; the lobes of the front are slightly more oblique (sloping outward and backward); the longitudinally oblique furrow on the branchial region is less distinct and more curved; the rugosities of the carapace are quite as strong but not so extended (toward the middle of the back); the teeth of the prehensile edges of the fingers stronger, the enlarged teeth being more distinctly different in size from the intermediate teeth.

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[1] Smithson Misc. Coll., 1907, **49**, p. 55, pl. 6, fig. 7.

[2] In Max Weber, Zool. Ergeb. Niederl. Ost-Indien, 1892, **2**, pl. 16, fig. 5–5*d*.

Potamon (Potamonautes) cunicularis (Westwood).

Plate 4, fig. 3.

Potamon (*Potamonautes*) *cunicularis* Rathbun, *op. cit.*, 1904 (4), **6**, pl. 15, fig. 10; 1905 (4), **7**, p. 184.

India: Teesta Valley, at junction of Teesta and Rungeet rivers, border of Bhutan; 1 ♂ juv., 16 mm. long by 20.4 mm. wide. This specimen is considerably narrower than the adult male and also shows other differences which may be due to age. The epigastric lobes (forming the median portion of the postfrontal crest) are a little more oblique; the middle part of the upper border of the orbit is horizontal; the furrow of the ischiognath is deep.

If the identification be correct (no specimens are at hand for comparison), the range of this Indian species is extended; it has not heretofore been recorded from north of lat. 19° 23′ N.[1]

Potamon (Parathelphusa) spiniger (Wood-Mason).

Potamon (*Parathelphusa*) *spiniger* Rathbun, *op. cit.*, 1904 (4), **6**, pl. 17, fig. 1; 1905 (4), **7**, p. 231.

India: Jungle pond 20 miles southeast of Lucknow; 1 ♂ 2 ♀.

Potamon (Parathelphusa) tridentatus (Milne Edwards).

Potamon (*Parathelphusa*) *tridentatus* Rathbun, *op. cit.*, 1905 (4), **7**, p. 234, pl. 13, (Potamonidae 11), fig. 2.

Java: River Tjiliwong, in Botanical Gardens, Buitenzorg, 850 feet altitude; 1 ♂ 5 ♀.

The male measures 29 mm. long, 36.8 mm. wide, 22 mm. between the outer angles of the orbits, 10.2 mm. across lower edge of front. The greatest width is behind the tips of the posterior of the lateral teeth. Occurs with *P. convexus*, but distinguished at sight by its flatter carapace and larger teeth on the lateral margins; comparing the largest males of both species, the abdomen is seen to be much smaller in *convexus;* the sixth segment is about as long as its proximal width in *tridentatus*, but distinctly longer than wide in *convexus*.

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[1] This paper was in press before the publication of Alcock's work on the Potamonidae of India, and at the time of proof correction his memoir is not at hand for comparison.

Potamon (Parathelphusa) convexus (DE MAN).

Potamon (*Parathelphusa*) *convexus* Rathbun, *op. cit.*, 1905 (4), **7**, p. 237, pl. 13 (Potamonidae 11), fig. 8, text fig. 56.

Java: River Tjiliwong, in Botanical Gardens, Buitenzorg, 850 feet altitude; 23 ♂ 14 ♀. A fine series showing growth variations.

Potamon (Parathelphusa) dayanus (WOOD-MASON).

Potamon (*Parathelphusa*) *dayanus* Rathbun, *op. cit.*, 1905 (4), **7**, p. 259, pl. 14 (Potamonidae 12), fig. 7.

India: Mandalay, Upper Burma, in small pond near Theebaw's palace; 1 ♀, 31.2 mm. long, 43.3 mm. wide. Comparing this with a female previously described from Rangoon (*loc. cit.*), the carapace is seen to be smoother (the grooves being partially obliterated). On the right side there are five teeth instead of four, an extra and very short tooth being inserted at the base of the first tooth.

Potamon (Parathelphusa) barbouri, sp. nov.

Plate 5, figs. 1-2.

Java: Buitenzorg; 1 ♂ juv., having on the right side the cheliped and first and fourth legs, and on the left side the first and a part of the third and fourth legs.

Carapace depressed, subquadrate, its length $\frac{5}{6}$ of its width; surface punctate, the punctae connecting by reticulating impressed lines; short faint granulated oblique lines near lateral margins. Cervical suture rather deep, interrupted on either side. Narrow part of mesogastric region defined only at anterior end, from which a deep groove is continued forward, separating the oblique, slightly curved, rugose epigastric lobes. Considerably behind and outside the latter arise the protogastric ridges, which are well defined, acute, crenulated, slightly convex and slightly oblique, stopping far short of the lateral margin and opposite the middle of the second tooth.

Margin of front and orbits crenulate; lower edge of front about $\frac{1}{3}$ as wide as carapace, faintly bilobed by a very broad shallow sinus; sides of front very oblique, upper margin of orbit inclined slightly backward and outward. Anterolateral teeth five (including the orbital tooth), similar, spiniform, the first one directed forward, the others obliquely outward; the second is a little longer than the others on its outer margin, which is sinuous.

Lower margin of orbit granulate, in ventral view sloping obliquely backward and outward; a stout spine at inner angle. Merus of outer maxilliped very wide and in a plane almost at right angles to that of the ischium; the latter is without a furrow. Cheliped $1\frac{1}{2}$ times as long as carapace; surface of merus and carpus crossed by fine granulated lines, palm sparingly granulated, granules most visible on upper surface; a sharp subdistal spine on upper margin of merus, and a very strong curved spine at inner angle of carpus; chela weak (in the young male); the greatest length of the dactylus equals the middle length of the palm, and the height of the palm is a little greater than its superior length; fingers irregularly dentate and narrowly gaping for their basal half. Fourth leg a trifle longer than first and 1½ times as long as carapace; merus joints with a blunt subdistal angle, that of third leg widening in the middle portion; propodus of last leg ¾ as long as dactylus, measured on outer margin.

Abdomen of male subtriangular, with the margin from the third to the sixth segment concave; first segment widest, second next, third next; first segment crossed by a sharp, laminar, transverse crest; suture between second and third and between fifth and sixth straight, and suture between third and fourth and between fourth and fifth concave forward, so that segment 3 is wider in its outer part than in the middle, and segment 5 is wider in the middle than at the sides; segment 7 subtriangular, sides concave, end rounded.

Dimensions. — ♂, length 13.5 mm., greatest width (at fourth tooth) 16.4 mm., width between outer angles of orbit 14 mm., width of front on anterior edge 5.6 mm.

Type 7242 Coll. Museum of Comparative Zoölogy.

P. barbouri is the only *Parathelphusa* known with exactly five similar teeth and no additional spinules. All the species with numerous (more than four) spines and spinules are restricted to the continents of Africa and Asia.

PORTUNIDAE.

Portunus sanguinolentus (Herbst).

Neptunus sanguinolentus Alcock, *op. cit.*, 1899, **68**, p. 32.

Celebes: Makassar; 1 ♀ juv.

Portunus pelagicus (Linné).

Neptunus pelagicus Alcock, *op. cit.*, 1899, **68**, p. 34.

Celebes: Makassar; 2 ♂ juv.

Charybdis cruciata (Herbst).

Charybdis (*Goniosoma*) *crucifera* Alcock, *op. cit.*, 1899, **68**, p. 51.

Celebes: Makassar; 1 small ♂.

Thalamita crenata Latreille.

Thalamita crenata Alcock, *op. cit.*, 1899, **68**, p. 76.

Celebes: Makassar; 1 ♀.
Moluccas: Amboyna; 1 ♀.

Thalamita prymna (Herbst).

Thalamita prymna Alcock, *op. cit.*, 1899, **68**, p. 78.

Dutch New Guinea: Sorong; 1 ♂.

COENOBITIDAE.

Coenobita brevimanus Dana.

Cenobita clypeata and var. *brevimana* Dana, Crust. U. S. Expl. Exped., 1852, **1**, p. 473; atlas, 1855, pl. 30, fig. 4*a–b*.

Coenobita clypeatus Latreille. Alcock, Cat. Indian Dec. Crust., 1905, pt. 2, fasc. 1, p. 142, pl. 15, figs. 1, 1*a*. Not *Cancer clypeatus* Herbst, 1791.

Moluccas: Tifou Bay, Bouron Island; 1 egg-bearing ♀, with carapace 25.8 mm. long.

Coenobita rugosus Milne Edwards.

Coenobita rugosus Alcock, *op. cit.*, 1905, pt. 2, fasc. 1, p. 143, pl. 14, figs. 3, 3a.

Bali: Boeleleng; 91 specimens.
Moluccas: Wahaai, Ceram Island; 2 specimens.
Moluccas: Patani, Halmaheira Island; 2 specimens.
Dutch New Guinea: Djamna, at high-water mark; 4 specimens.
Dutch New Guinea: Jendee, Roon Island; 4 specimens.
Dutch New Guinea: Sorong; 4 specimens.

Coenobita cavipes Stimpson.

Coenobita cavipes Alcock, *op. cit.*, 1905, pt. 2, fasc. 1, p. 146, pl. 14, fig. 1.

Moluccas: Patani, Halmaheira Island; 1 specimen without large claw.
Moluccas: Ternate; 1 specimen.

PORCELLANIDAE.

Petrolisthes dentatus (Milne Edwards).

Porcellana dentata de Man, Journ. Linn. Soc. London, Zool., 1888, **22**, p. 216.

Moluccas: Amboyna; 1 ovigerous ♀, 5.4 mm. long.

THAUMASTOCHELIDAE.

Thaumastocheles zaleucus (Willemoes-Suhm).

Plate 6, figs. 1–3.

Astacus zaleucus Willemoes-Suhm, Trans. Linn. Soc. London, 1875 (2), **1**, p. 49, pl. 10, fig. 1, near Sombrero Island, W. I., 450 fathoms, 1 ♀ (not ♂) and chelae of a smaller specimen perhaps ♂.

Thaumastocheles zaleucus Wood-Mason, Proc. Asiat. Soc. Bengal, 1874, p. 181; 1875, p. 231.

Thaumastocheles zaleuca Spence Bate, Challenger Rept., 1888, **24**, pt. 52, p. 47, pls. 6, 7, fig. 1.

Thaumastocheles zaleucus Doflein, Zool. Anz., 1906, **30**, p. 521, text figs. 1–4, deep-sea bank at entrance of Sagami Bay, 1 ♂.

Sagami Bay, about 350 fathoms; Owston collection: 1♀. This specimen is larger than any yet recorded: Length 153.5 mm., of which the carapace measures 58.5 mm.; length of large chela 108 mm., of small chela 53.5 mm.

The anterior margin of the carapace outside of the rostrum is nearly transverse; this is not the case in Bate's figure, but is so in Willemoes-Suhm's figure of the same specimen. The larger palm is more swollen in relation to the size of the body; its anterior half has about 8 small spines above, 5 below, and a subdistal spine on the inner side. The fingers move horizontally, the teeth of the immovable finger slipping over those of the movable finger when closed; on the proximal half, the spines of the two fingers form an angle with each other, as shown in Doflein's figure.

PALINURIDAE.

Palinurus ornatus (FABRICIUS ?, MILNE EDWARDS).

Senex ornatus Ortmann, Zool. Jahrb. Syst., 1891, **6**, p. 34.

Dutch New Guinea: Sorong; 2 young specimens. In the larger specimen, the carapace and abdomen measure 33 mm., antenna 56 mm. (tip broken off). There is a transverse whitish band near the posterior end of each of the first six segments of the abdomen; also a longitudinal light band along the side of the carapace; legs violet, longitudinally striped with whitish.

PENEIDAE.

Peneus semisulcatus (DE HAAN).

Peneus semisulcatus Alcock Cat. Ind. Dec. Crust., 1906, pt. 3, fasc. 1, p. 10, pl. 1, fig. 2.

Celebes: Makassar; 1♀.

Peneus indicus merguiensis (DE MAN).

Peneus indicus var. *merguiensis* Alcock, *op. cit.*, 1906, pt. 3, fasc. 1, p. 13, pl. 2, fig. 4 (not pl. 19, fig. 1 of de Man).

Celebes: Makassar; 1.

CRANGONIDAE (= *Alpheidae*).

Crangon (= *Alpheus*), sp.

Moluccas: Amboyna; 1 specimen without chelipeds.

ATYIDAE.

Atya moluccensis DE HAAN.

Atya moluccensis de Man, in Weber, Zool. Ergeb. Reise Niederl. Ost-indien. 1892. **2**, p. 357, pl. 21, fig. 20.

Java: Buitenzorg; 5 specimens.
Bali: Boeleleng, small pond near landing place; 2 small specimens.

Caridina wyckii gracilipes DE MAN.

Caridina wyckii var. *gracilipes* de Man, *op. cit.*, 1892, **2**, p. 387, pl. 24, figs. 29–29*e*.

Lombok: Ampenan, fresh water; 4 specimens.
Celebes: Makassar, fresh water; 27 specimens.

PALAEMONIDAE.

Palaemon concinnus DANA.

Leander concinnus de Man, *op. cit.*, 1892, **2**, p. 506.

Bali: Boeleleng, small pond near landing place (fresh water); 1 specimen.
Lombok: Ampenan, fresh water; 1 specimen.

Bithynis (Eupalaemon) sundaicus (HELLER).

Palaemon (*Eupalaemon*) *sundaicus* de Man, *op. cit.*, 1892, **2**, p. 437, pl. 26, fig. 35.

Celebes: Makassar; 2 ♀ (only one claw of second pair). The rostrum is turned distinctly upward at the end and reaches beyond the antennal scale. Rostral formula in each $\frac{11 \text{ (2 on carapace)}}{4}$. In specimen 64 mm. long, the fingers and palm of second cheliped are equal and a little shorter than the merus.

Bithynis (Eupalaemon) elegans (DE MAN).

Palaemon (*Eupalaemon*) *elegans* de Man, *op. cit.*, 1892, **2**, p. 440, pl. 26, fig. 36.

Java: Buitenzorg, fresh water; 18 specimens, mostly without claws; only 6 claws of second pair present.

Bithynis (Eupalaemon) lar (FABRICIUS).

Palaemon (*Eupalaemon*) *lar* de Man, *op. cit.*, 1892, **2**, p. 445.

Bali: Boeleleng, small pond near landing place; 1 ♂ 1 ♀ ovigerous, both lacking claws of second pair.

Bithynis (Parapalaemon) hendersoni (DE MAN).

Plate 5, fig. 3.

Palaemon (*Parapalaemon ?*) *hendersoni* de Man, Ann. Mag. Nat. Hist., 1906 (7), **17**, p. 405, Darjeeling, Bengal, 2500 feet altitude.

Burma: Gokteik Gorge, border of the southern Shan States, between 3000 and 4000 feet altitude; 5 ♂ 4 ♀. Eleven legs of the second pair are present but mostly detached.

The length of the rostrum varies, reaching from the middle of the penultimate segment to the middle of the last segment of the antennular stalk; the number of teeth ranges from 7 to 10 above (2 or 3 on carapace), usually 7 or 8, and from 2 to 3 below, usually 2; 3 specimens have the formula $\frac{7\ (2)}{2}$ (the number in parenthesis being those on the carapace); 4 specimens $\frac{8\ (2)}{2}$, 1 specimen $\frac{8\ (3)}{2}$, 1 specimen $\frac{10\ (2)}{3}$. De Man gives $\frac{7 \text{ or } 6\ (3)}{1\text{–}2}$; his specimens are nearly twice as large as those at hand.

In the largest specimen, a ♀ 37 mm. long, the right second claw, which I take to be the larger of the pair (the left one is absent), measures, merus 4.2 mm., carpus 3.8 mm., palm 5.7 mm., fingers 5.2 mm. In most of the chelae of the second pair, the palm is a little longer than the fingers; in the few cases where the fingers are a little longer than the palm, the cheliped may be the smaller of the two, as in the one measured by de Man.

Bithynis (Macrobrachium) pilimanus (DE MAN).

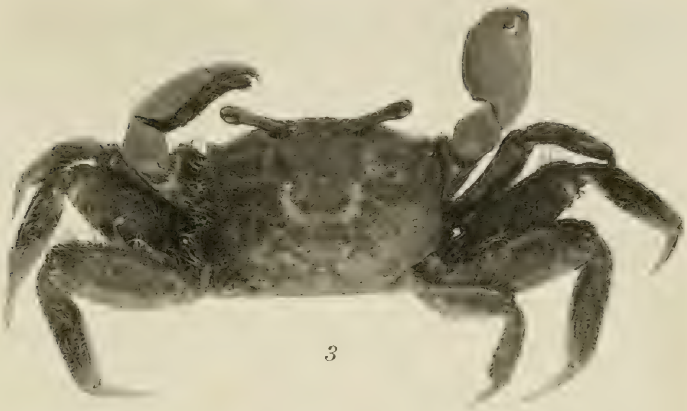
Palaemon (*Macrobrachium*) *pilimanus* de Man, in Weber, Zool. Ergeb. Reise Niederl. Ost-Indien, 1892, 2, p. 471, pls. 27 and 28, fig. 44.

Java: Buitenzorg, fresh water; 11 specimens mostly small; only 3 claws of the second pair present.

EXPLANATION OF THE PLATES.

PLATE 1.

Fig. 1. Uca perplexa ♂. Wahaai. Dorsal. × 2.
Fig. 2. Uca perplexa ♂. Wahaai. Ventral. × 2.
Fig. 3. Macrophthalmus pacificus ♂. Dorsal. × 2.



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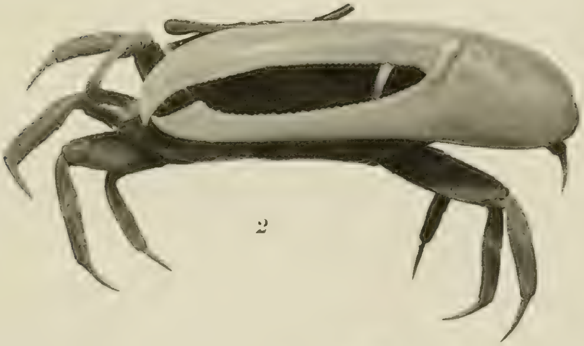

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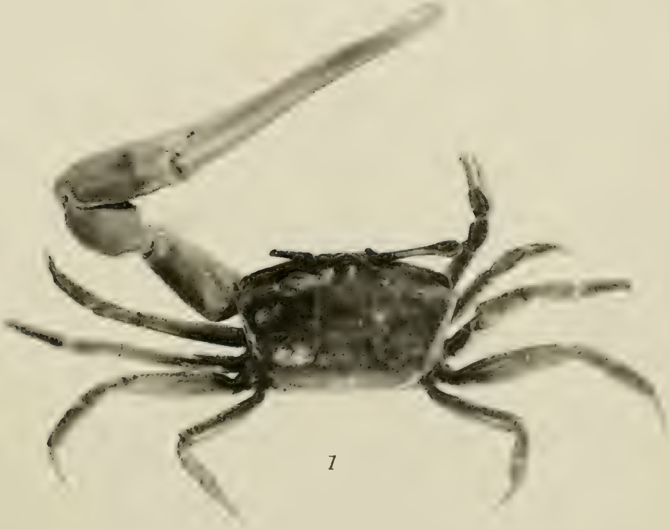

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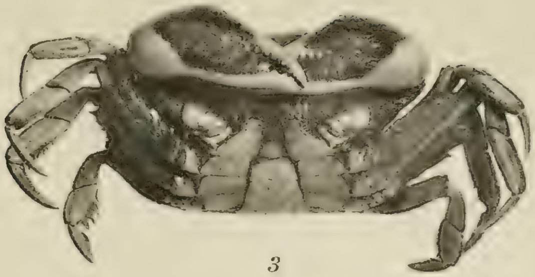
PLATE 2.

Fig. 1. Macrophthalmus definitus ♀. Dorsal. Nat. size.
Fig. 2. Utica nausithoe ♂. Dorsal. Nat. size.
Fig. 3. Utica nausithoe ♂. Ventral. Nat. size.



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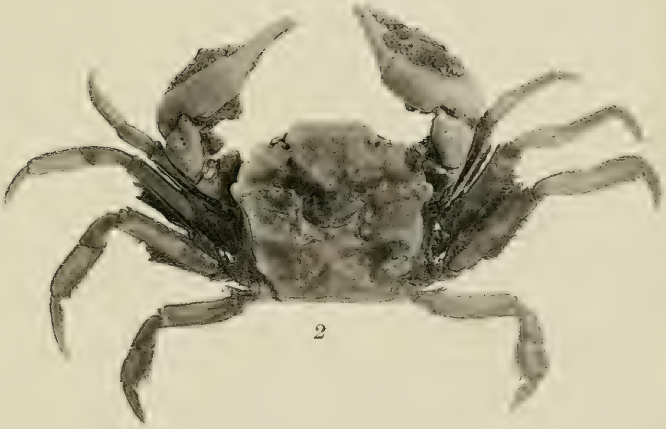

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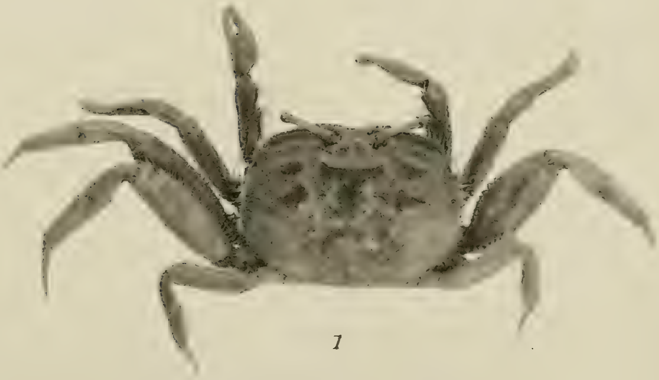

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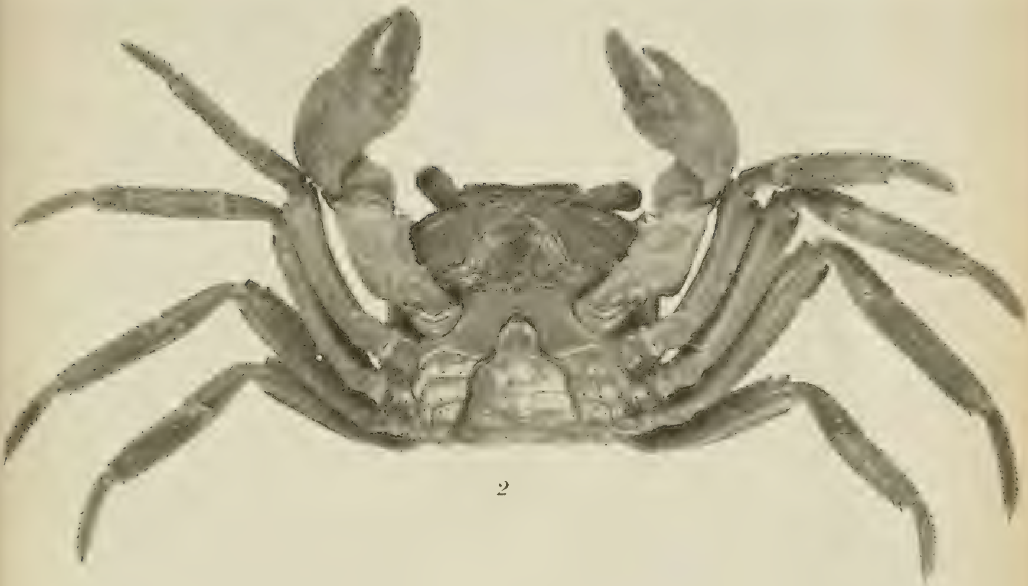
PLATE 3.

Fig. 1. Sesarma (Sesarma) gracilipes ♂. Dorsal. × 2.
Fig. 2. Sesarma (Sesarma) gracilipes ♂. Ventral. × 2.



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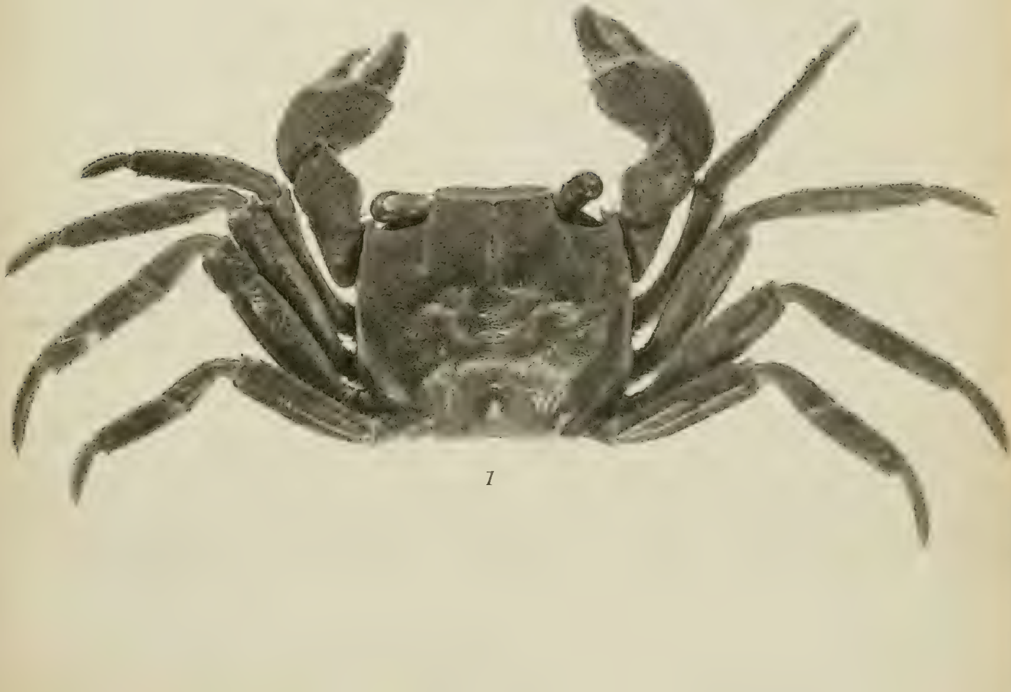

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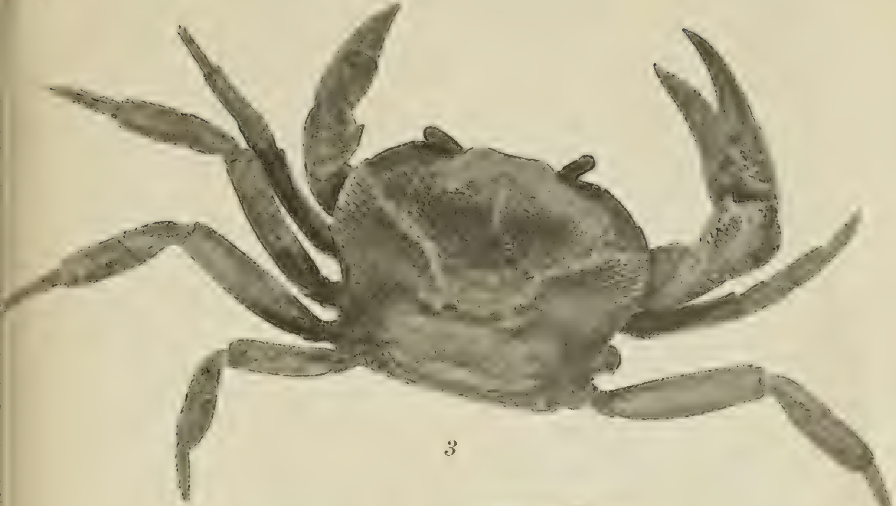
PLATE 4.

Fig. 1. Sesarma (Parasesarma) leptosoma ♀. Dorsal. × 2.
Fig. 2. Potamon (Potamon) granulatus ♂. Dorsal. Nat. size.
Fig. 3. Potamon (Potamonautes) cunicularis ♂. Dorsal. × 2.



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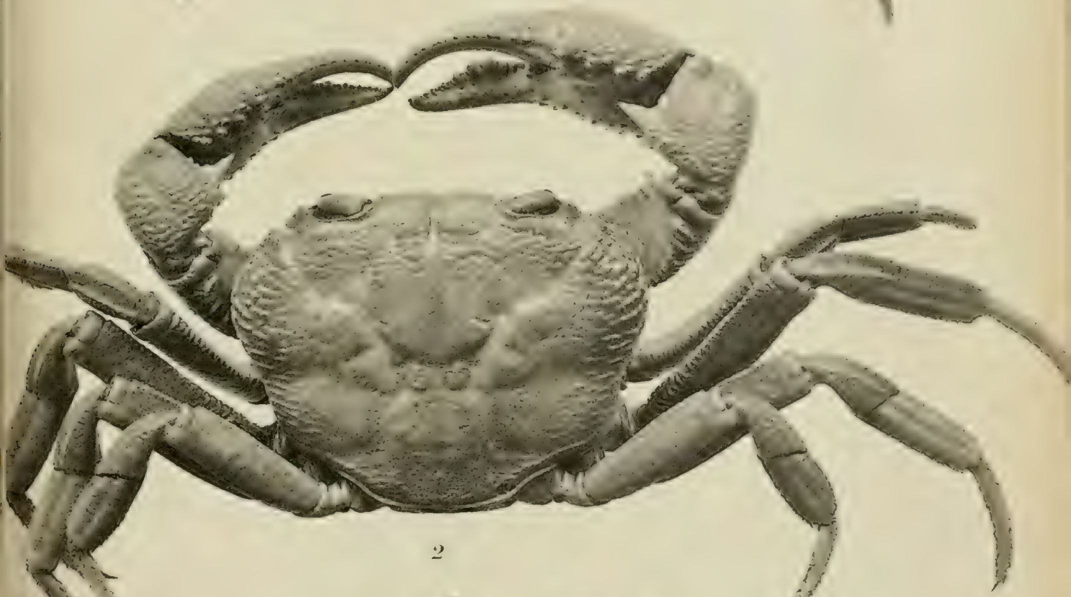

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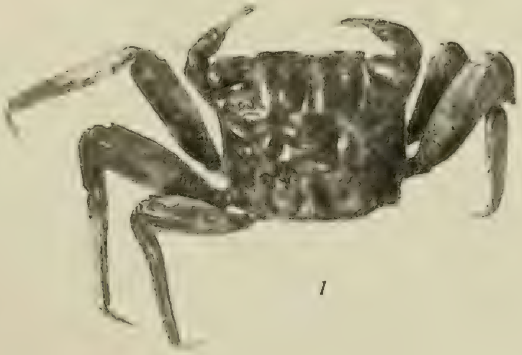

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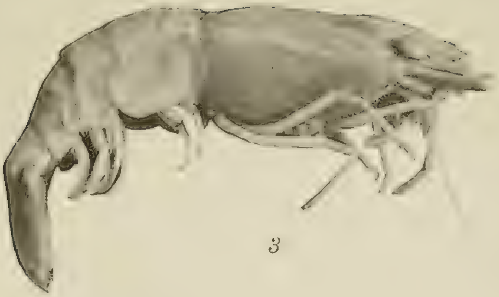
PLATE 5.

Fig. 1. Potamon (Parathelphusa) barbouri ♂. Dorsal. × 2.
Fig. 2. Potamon (Parathelphusa) barbouri ♂. Ventral. × 2.
Fig. 3. Bithynis (Parapalaemon) hendersoni ♀. Right side. × 2.



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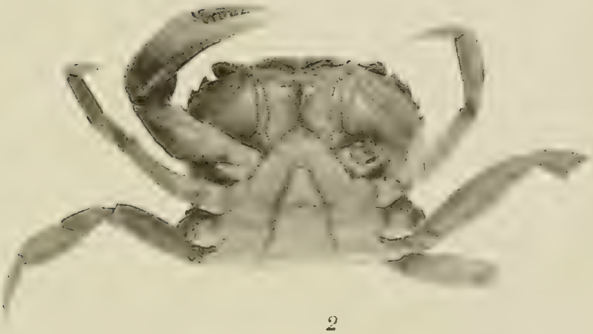

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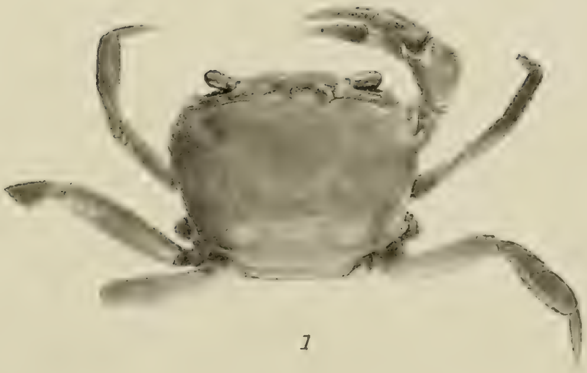

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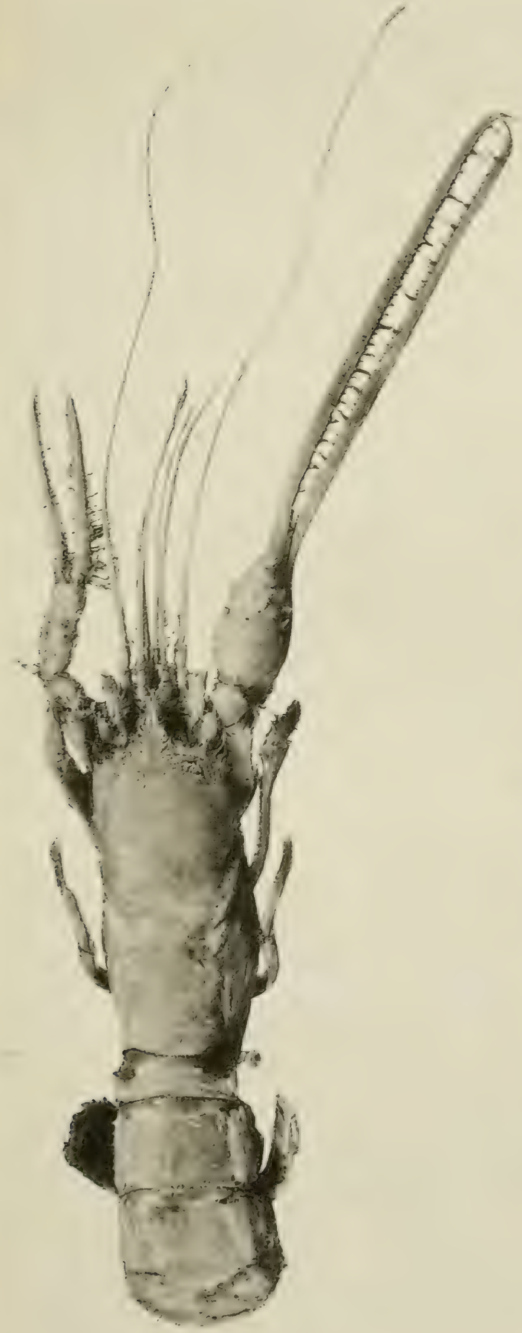
PLATE 6.

Fig. 1. Thaumastocheles zaleucus ♀. Dorsal. Nat. size.
Fig. 2. Thaumastocheles zaleucus ♀. Right side. Nat. size.



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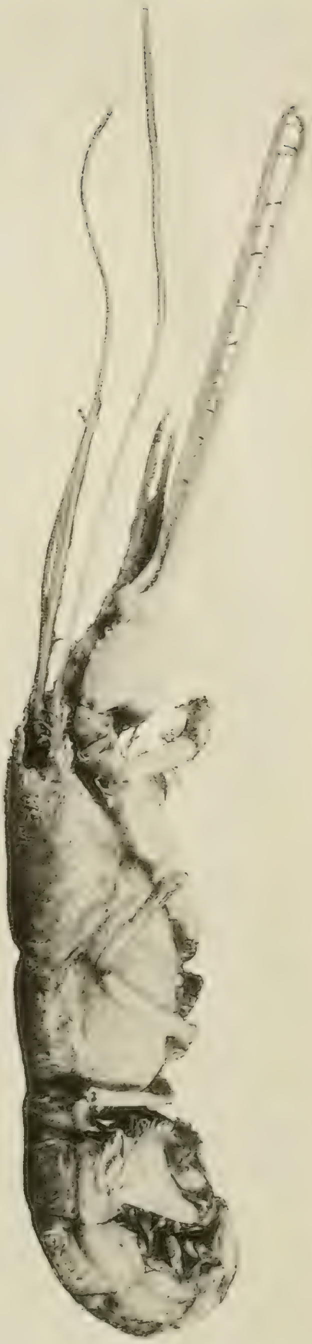

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LII. No. 17.

THE ECHINODERMS OF PERU.

BY HUBERT LYMAN CLARK.

WITH FOURTEEN PLATES.

CAMBRIDGE, MASS., U. S. A.:
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OCTOBER, 1910.

No. 17. *The Echinoderms of Peru.* By Hubert Lyman Clark.

The following report, prepared at the request of the Ministerio de Fomento, of the Peruvian Government, as a contribution to the knowledge of the aquatic resources of Peru, is for use in connection with marine investigations in that country, though the needs of the general zoölogist and particularly of those chiefly interested in the fishes and fisheries of Peru, have been kept in mind. The keys are therefore as simple as possible and are based, so far as practicable, on obvious external characters; they are consequently very artificial. The report is based primarily on the collection of echinoderms made by Dr. Robert E. Coker in 1907–08, and I am glad to express my thanks to him for the opportunity to study the collection, and for the use of his field notes and other data. In addition to the species found in this collection I have included all the echinoderms actually known to occur south of the equator and north of 40° S. latitude, and which may therefore be reasonably expected to occur on the coasts of Peru. I have not included any species described from such indefinite localities as "west coast of South America," "Chile," "Ecuador," or "west coast of Colombia," unless they have since been recorded from the given coastal area, excepting such rare cases as *Holothuria chilensis*, where the genus is a tropical (or subtropical) one and the species is described as from Chile. The collection in the Museum of Comparative Zoölogy, which contains many South American species, a large number of which were brought home by the "Hassler" expedition, has been of great assistance. In it were found two new starfishes.

The Peruvian echinoderm fauna is not a rich one. There are no crinoids known from the region, and only seven holothurians and ten ophiurans. The echini are represented by a dozen species, and the starfishes by twice that number. Clearly the starfishes are the predominating feature, and this would be even more striking if the numerous species described from Ecuador and Colombia, some of which may ultimately be found on the northern coast of Peru, were included. It is interesting to note that the Peruvian marine fauna is made up of two quite different elements, that from the Panamic region and that from the Chilean. The latter furnishes all of the echinoderms found south of Aguja Point, 6° S. lat., while the Panamic fauna is practically confined to the shores north of that point. In spite of its low latitude the coast of Peru south of Aguja Point is far from tropical, and the marine life is distinctly that of temperate seas, owing to the great Humboldt or Peruvian current, which brings the cold waters of the antarctic region down nearly to the equator.[1]

Of the fifty-four echinoderms included in this report, twenty-one are found only on the less than two hundred miles of coast north of Aguja Point, while of the remaining thirty-three species only about a dozen really characterize the succeeding shore line of over twelve hundred miles. Some fifteen species occur both north and south of Aguja Point, while the range of at least half a dozen species is practically unknown. A more detailed analysis of the fauna brings out some of its most interesting features and reveals the striking contrast between its two components. North of Aguja Point the following twenty-two species have been taken, none of which has yet been recorded from far south of there. Those marked * are in the Coker collection.

*Astropecten erinaceus
fragilis
* peruvianus
*Luidia columbia
Nidorellia armata
Oreaster occidentalis
Paulia horrida
Phataria unifascialis
Ophioderma panamensis
Amphiodia grisea
Hemipholis gracilis
*Ophiothrix magnifica
* spiculata
Gorgonocephalus panamensis
Arbacia stellata
Echinometra van brunti
*Encope micropora
Mellita pacifica
* stokesii
Lovenia cordiformis
*Agassizia scrobiculata
*Thyone gibber

Three of these species (*Astropecten peruvianus*, *Amphiodia grisea*, *Ophiothrix magnifica*) seem to have a very restricted range, as they are not known from north of the equator, but the remaining nineteen species are distinctly Panamic. To these nineteen should be added *Pharia pyramidata*, the occurrence of which south of Aguja Point is open to very serious question, and the single specimen of *Mithrodia bradleyi*, labeled "Arica," is not sufficient proof of its occurrence south of the Panamic region. The new *Luidia phragma* probably belongs in this group also, but the exact point on the South American coast where it was taken is not known. The Panamic element in the Peruvian fauna, therefore, contains twenty-five species, but many of these must be of irregular or rare occurrence, since only nine are in the Coker collection.

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[1] For an account of the characteristics of the Peruvian coast see Coker, Bull. Bureau of Fisheries, 1910, **28**, pp. 335–340.

South of Aguja Point twenty-six species have been taken.[1] Of these, two (*Luidia bellonae* and *Stichopus fuscus*) have a remarkable range, extending from the Gulf of California to Chile and (in the case of Stichopus) even to Patagonia. Another (*Heliaster polybrachius*) is known only from the Peruvian coast in the vicinity of Aguja Point (say 3° 30′ – 7° 30′ S. lat.) and certainly cannot be classed with the Chilean fauna. The little ophiuran taken by Coker near San Lorenzo Island, off Callao, is apparently *Amphipholis pugetana*, a North American species; it is certainly not *A. laevidisca*, known from Chile; the genus is cosmopolitan, and some excellent authorities consider that *A. squamata* is equally wide-ranging, and they would doubtless refer these Peruvian specimens to it. Deducting these four species, there are twenty-two which may fairly be referred to the Chilean fauna. Of these, the following eight have been reported from north of Aguja Point:

Asterina chilensis
Stichaster aurantiacus
Heliaster helianthus
Ophiactis kröyeri
Tetrapygus niger
Arbacia spatuligera
Strongylocentrotus gibbosus
Phyllophorus peruvianus

These species are all in the Coker collection, but the specimens of Phyllophorus were not taken north of 9° S. lat. Of the remaining fourteen species supposed to occur along the southern shores of Peru, only *Strongylocentrotus albus* was taken by Dr. Coker:

Tosia verrucosa
Odontaster singularis
Asterina calcarata
Parasterina obesa
Echinaster cribella
  cylindricus
Henricia hyadesi
Asterias gelatinosa
Amphipholis laevidiscus
Amphiodia chilensis
Podophora pedifera
Strongylocentrotus albus
Cucumaria leonina
  godeffroyi

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[1] The exact localities where *Ophidiaster ludwigi*, recorded from "Perou," *Holothuria chilensis* from "Chile," and *Colochirus peruanus* from "Peru," were taken are unknown, and they are omitted from this discussion.

The Tosia, Asterina, Parasterina, both species of Echinaster, and the Amphipholis are known only from the original specimens (all but one of which were from Chile) and have not been met with by other collectors. The Odontaster and Henricia are species of the far south and are included in this list only because each has been reported once from northern Chile, near Iquique; their occurrence on the Peruvian coast is quite unlikely. The Asterias and Amphiodia and both Cucumarias are Chilean species, which very probably occur, at least occasionally, in Peruvian waters. Although there are specimens of Podophora in the M. C. Z. collection labeled as from "Valparaiso" and "Callao," it seems extremely improbable that these specimens were actually collected in South America, for the genus is a highly specialized one, characteristic of the Indo-Pacific region, and it could hardly have escaped the notice of such collectors as Plate and Coker, if it occurred on the coasts of either Chile or Peru at the present day. It is clear, then, that the known Chilean element in the Peruvian fauna is very small, and all of the species which undoubtedly occur were taken by Dr. Coker, except an Echinaster and a Cucumaria. South of Aguja Point, then, one may expect to find, in suitable places, four species of starfish (*Luidia bellonae*, *Asterina chilensis*, *Stichaster aurantiacus*, *Heliaster helianthus*), one ophiuran (*Ophiactis kröyeri*), four sea-urchins (*Tetrapygus niger*, *Arbacia spatuligera*, *Strongylocentrotus albus*, *S. gibbosus*), and one holothurian (*Phyllophorus peruvianus*). North of Aguja Point, however, one finds a much more varied fauna and may reasonably expect ten or more species of starfishes, (three species of Astropecten, two or three of Luidia, Nidorellia, Oreaster, Paulia, Phataria, Pharia, Asterina, at least one Heliaster, and, possibly, Stichaster), several ophiurans (Ophioderma, Ophiactis, Amphipholis or Amphiodia, possibly Hemipholis, and two forms of Ophiothrix), eight or ten sea-urchins (Tetrapygus, one or two species of Arbacia, Echinometra, *Strongylocentrotus gibbosus*, Encope, one or two Mellitas, Agassizia, and perhaps Lovenia), and one or more holothurians (Thyone, Phyllophorus, or Stichopus).

Starfishes. Asteroidea.

The starfishes comprise not only almost one half of all the echinoderms known from the Peruvian region, but also the great majority of the conspicuous or structurally interesting forms. More than half are large species, reaching a diameter of over five inches, and several rank among the largest known starfishes. The twenty-five species represent eighteen genera, of which five are known only from the west coast of Central and South America. Ten of the species are not known outside of the region included in this report, while eleven others are well-known Panamic species. There can be little question that most of the starfishes came to the Peruvian coast from the north. We know too little about *Tosia verrucosa* and *Parasterina obesa* to be positive as to their origin, but they probably came from the south. The two species of Asterina may have come from the south, but it is quite as possible that they are of northern stock. Odontaster is unquestionably a southern genus and *Henricia hyadesi* certainly came up from the south. The south also may be considered the home of *Asterias gelatinosa*, which has hardly reached the Peruvian coast yet, and while there is lack of definite evidence bearing on the point, *Stichaster aurantiacus* may be considered as an immigrant from the south. But with these exceptions the starfishes of the Peruvian coast are undoubtedly of northern (Panamic) origin.

In discussing the characteristic features of starfishes, a few terms require a word of explanation. In many species the dorsal skeletal plates develop vertical, table-like outgrowths, called *paxillae;* the tops (*tabulae*) of these paxillae are square, oblong, polygonal or more or less circular, and are usually so crowded as to form a second covering to the dorsal surface of the animal, between which and the true surface there is a more or less considerable space, traversed vertically by the columns or stalks of the paxillae; the *tabulae* bear spinelets or granules along their margins and on the free upper surface, and sometimes the central spinelet may develop into a conspicuous spine. The sides of the rays in many starfishes are defined by an upper and lower series of plates, the *supero-* and *infero-marginals;* in some starfishes the marginal plates are very large and conspicuous even in the *interbrachial areas* (*i. e.*, the space on the body between the bases of adjoining rays), while in others they are small and inconspicuous, and in the most highly specialized forms they are completely hidden and indistinguishable; in Luidia the superomarginals appear to be wanting, but the inferomarginals are fairly conspicuous. In most starfishes which lack paxillae, minute, finger-like papillae project between the plates of the dorsal skeleton; these are probably respiratory organs and are known as *papulae;* the papulae are often single, but are usually grouped in the areas between the skeletal plates, and these are then referred to as *papular areas.* The *madreporic plate* is usually conspicuous on the dorsal side in an interbrachial area, but in species having paxillae it is often hard to find. The sides of the furrow, on the under side of each ray, in which the tube-feet are located, are guarded by a series of plates, each of which carries a row or group of spines; the plates are called the adambulacral plates and the spines make up the *adambulacral armature.* In describing starfishes, it is customary, for brevity's sake, to let R stand for the major radius, *i. e.*, from the center of the mouth to the tip of a ray, and r stand for the minor radius, *i. e.* from the center of the mouth to the middle of an interbrachial margin; in a perfectly circular starfish, we would say, R = r; in an ordinary pentagonal starfish R = r +, while in a starfish with long rays R = 6r, more or less.

Key to the Starfishes of the Peruvian Coast.

- Upper surface covered with paxillae; general form decidedly flattened; inferomarginal plates with long spines forming a conspicuous lateral fringe along the ray.
  - Superomarginal plates conspicuous in contrast to paxillae (*Astropecten*).
    - Superomarginal plates, each with one or two prominent vertical spinelets.
      - Superomarginal plates at base of ray (but not in interbrachial area) with two spinelets each, one on inner edge and one near outer margin . . . . *A. erinaceus*
      - Superomarginal plates with only a single spinelet each, except that a few near tip of ray may carry a second small one . . *A. peruvianus*
    - Superomarginal plates without spinelets; some of those near base of ray may carry, each, a small rounded tubercle . . . . *A. fragilis*
  - Superomarginal plates reduced and not readily distinguishable beneath paxillae (*Luidia*).
    - Each paxilla in third longitudinal series at side of ray carries, except near tip of ray, a long slender spine . . . . *L. phragma*
    - None of the paxillae carry long and slender spines.
      - Inferomarginal plates, each with a longitudinal (transverse to long axis of ray) series of 4–6 flattened, usually blunt or truncate spines; many paxillae have central spinelet enlarged into a blunt elevated tubercle or sharp, stout spine . . . . *L. bellonae*
      - Inferomarginal plates, each with 2 or 3 long, sharp spines; no paxillae (except occasionally some along sides of ray) with large central tubercle or spinelet . . . . *L. columbia*
- Upper surface without paxillae; sides of ray without lateral fringe of slender inferomarginal spines.
  - Tube-feet in two series in each ambulacrum; rays normally five.
    - Disc large and rays short; form often pentagonal; R never more than 2.5r.
      - Marginal plates conspicuous, forming a definite boundary to the more or less pentagonal body.
        - Marginal plates and disc free from large spines.
          - Superomarginal plates 19–20 on each side of each ray (in specimen 75 mm. across), covered by a close pavement of crowded granules . . . . *Tosia verrucosa*
          - Superomarginal plates 15–16 on side of ray (in specimen 75 mm. across), covered by a coat of distinct granules coarser than those of disc . . . . *Odontaster singularis*
        - Some marginal or disc plates or both, carry large spines *Nidorellia armata*

Marginal plates more or less concealed not forming a definite boundary to a pentagonal body.

Large species (R up to 150 mm.) with dorsal surface carrying numerous big sharp tubercles or spines or both.

Dorsal surface elevated, with coarse tubercles, granulated at base . . . . *Oreaster occidentalis*

Dorsal surface flat, with numerous, erect, smooth, very stout spines . . . . *Paulia horrida*

Small species (R seldom exceeds 25 mm.) with dorsal surface, entirely free from conspicuous spines or tubercles (*Asterina*).

Plates of ventral interbrachial areas with only 1 spine each . . . . *A. calcarata*

Plates of ventral interbrachial areas with 2–6 spines each . . . . *A. chilensis*

Disc small or moderate, R more than 3r and usually more than 4r.

Rays short and thick, about equal to 3r covered, as is the disc by groups of crowded blunt spinelets, simulating low paxillae. *Parasterina obesa*

Rays longer, 4–10r.

Disc and rays closely covered with a nearly smooth, granulated coat, without projecting spines, except beside ambulacral furrows.

Papular areas arranged in a single (rarely double) broad series along each side of ray . . . . *Phataria unifascialis*

Papular areas arranged in eight series on each ray.

Madreporic plate very large, its diameter .25 or more of disc diameter; rays somewhat trigonal; inner series of adambulacral armature made up of approximately equal and similar spines . . . . *Pharia pyramidata*

Madreporic plate much smaller; rays more or less cylindrical; inner series of adambulacral armature made up of alternating large and small spines . . . . . *Ophidiaster ludwigi*

Disc and rays bearing spines or spinelets, sometimes minute and crowded.

Spines and spinelets large, unequal and irregularly scattered, blunt, covered to tip with scale-like granules . . *Mithrodia bradleyi*

Spines and spinelets bare, often small or even minute.

Spinelets very minute, in more or less crowded groups on dorsal plates . . . . *Henricia hyadesi*

Spines well developed, arranged singly on dorsal plates (*Echinaster*).

Dorsal spines rather crowded, in irregular rows . . . *E. cribella*

Dorsal spines irregularly scattered . . . . *E. cylindricus*

Tube-feet in four, more or less distinct series in each ambulacrum.

Rays few, never more than eight.

Rays 5, with about 11 longitudinal, abactinal series of groups of closely crowded granule-like spinelets . . . . . *Stichaster aurantiacus*

Rays normally 6, rarely 5 or 7, with 5 longitudinal series of large, widely separated, abactinal spines . . . . *Asterias gelatinosa*

Rays numerous, up to forty-three (*Heliaster*).
  Rays very short, free from each other for only .15–.20 of length *H. polybrachius*
  Rays longer, free from each other .30–.40 of length . . . . *H. helianthus*

Astropecten erinaceus.

J. E. Gray, 1840. Ann. Mag. Nat. Hist., 6, p. 182.

Plate 1, figure 1.

Nothing is said by Gray as to either the size or color of this species. The largest specimens I have seen have the rays about 85 mm. long, but those taken by Coker do not exceed R = 75 mm. Most dry specimens are dull yellowish, more or less dusky above, while the best preserved specimens in the Coker collection are uniformly deep reddish fawn color. But in life the coloration must be much handsomer, for Coker's field notes show that the specimens taken at the mouth of the river Tumbes were "dorsally blue, except that the spines which margin the lower angles of arms are orange color in their dorsal aspect," while of the specimens taken at Capon it is said: "Under side white in small specimens, tinted orange in larger ones; bluish at tips of arms; above deep blue; the spines orange, those margining the arms are bright orange, while the dorsal spines are of a duller shade." The change from this bright coloration to the uniform reddish fawn color of the preserved specimens is very remarkable, but is of course due to the preserving fluids. These specimens were "first preserved in native spirits and subsequently transferred to formalin solution" (3–5% solution in sea-water). Such a marked change of color shows how little dependence can be placed on the color of preserved specimens not accompanied by field notes.

This is a Panamic species, ranging from about 25° N. to 3° 30′ S. lat. It was first collected by Cuming at St. Elena on the coast of Ecuador, about 2° S. lat., on a bottom of sandy mud in six fathoms of water. There are specimens in the M. C. Z. collection from Lower California and the Gulf of California. Coker took three specimens at the mouth of the river Tumbes and found the species abundant at Capon. Regarding its occurrence at Capon he says: "The water here is very quiet, and as the tide recedes most of these starfishes . . . slip away in the water, leaving, however, a very distinct impression of the form in the mud; so that when the mud-flat is exposed one may see in abundance the impressions of these starfishes, but without either the animals or any mark of their departure." It is probable that Dr. Coker is mistaken in supposing the starfishes to have slipped away in the water. Verrill (1901, p. 36) speaks of similar impressions made by Luidia, and he is satisfied, as he has himself told me, that the impression of the starfish in the sand is made *over* (not under) the starfish, and is caused by ciliary currents of water among the paxillae and marginal plates of the dorsal surface. If undisturbed, the starfish may by a sudden quick movement be captured *in situ*, but if disturbed by the approach of the collector, the animal moves away rapidly beneath the surface of the sand, leaving the impression in the sand undisturbed, Such habits indicate unusual activity for an echinoderm and deserve detailed and very careful observation and study.

Astropecten peruvianus.

A. E. Verrill, 1867. Trans. Conn. Acad., 1, p. 275.

This species is very similar to *erinaceus* in size and general appearance. Verrill does not refer to the color and, unfortunately, neither do Coker's field notes. The dry specimens are dull yellow above and nearly white beneath, with the madreporic plate orange. Verrill's specimens and Coker's also are from Payta, so there is no clue as to the range of the species. Coker took a dozen specimens "with boat-beam trawl, southeast of Caleta, Colon, Bay of Payta, 7–8 fms., soft mud, April 13," 1907. Though occurring in so much deeper water than *erinaceus*, there is no reason for expecting any difference in the habits of these species. I fully agree with Verrill that it is impossible to determine whether Gray's *stellatus* is this species or not.

Astropecten fragilis.

A. E. Verrill, 1867. Trans. Conn. Acad., 1, p. 272.

So far as I can learn this species has not been recorded since the original description was published. Verrill says nothing of the coloration, but gives the following measurements: R = 58 mm., r = 12.5 mm.; breadth of ray at base, 15 mm. (the measurements are given by Verrill in inches and tenths). The only known specimens are from Panama and Zorritos, Peru.

Luidia phragma, sp. nov.[1]

Plate 2, figure 1.

Rays 5. R = 73 mm., r = 12 mm., R = 6r. Interbrachial arcs acute. Rays very flat, tapering gradually to a point. Breadth at base, 14 mm. Disc moderate, flat; vertical diameter only about 7 mm. Paxillae of disc and median portion of rays small (.5–1 mm. in diameter of tabulae), irregularly circular, becoming squarish at sides of rays. Each paxilla has a dozen or more very slender, marginal spines, above which are half a dozen or more stouter ones, while the center of the tabula is occupied by 1–4 short, thick, blunt spinelets. Along each side of the ray are three longitudinal series of larger paxillae (1–1.25 mm. across), similar to the others, but more nearly rectangular. Innermost of these three rows, very conspicuous, each paxilla carrying, at center of tabula, a single, slender, sharp spine, 2–3 mm. long. These conspicuous spines form a fence or "palisade" along each side of ray about three millimeters from inferomarginal edge. Inferomarginal plates, with similar, though slightly larger spines; there are two to each plate, one above the other; the marginal fringe is thus very conspicuous. Seen from below the inferomarginal plates are well separated from each other; they have a marginal fringe of slender spinelets like those of the paxillae; the surface of the plate carries half a dozen flat, pointed spines, 1–2 mm. long, with a number of other smaller ones. Adambulacral armature of 3–4 spines in a single series, at right angles to furrow; innermost, smallest, sharp and slightly curved; the next is largest, 3 mm. long, straight (or nearly so) and blunt. Oral plates each with 4–6 spines, clustered at tip, and a similar number of variable size scattered on surface. Madreporic plate small, lying between the two terminal paxillae of the "palisade" series of two adjoining rays. Color (dry): disc and median area of rays pale gray with a yellowish tinge; paxillae outside of "palisade" series, all spines and entire lower surface more or less nearly white; there are several indistinct blotches of a darker gray on upper surface of rays.

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[1] φράγμα, a palisade, in reference to the palisade-like series of spines along the sides of the rays.

The specimen described above and two others are in the M. C. Z. collection, labeled "Chile or Sandwich Islands." As they were presented by Dr. W. H. Jones, U. S. N., in April, 1874, and as most of the specimens received from him at that time were from Chile and Peru, these Luidias are doubtless from the same locality. This probability is rendered almost a certainty by the fact that the M. C. Z. collection contains 14 specimens of what appears to be the same species, from the Gulf of California, collected by W. J. Fisher. They are dry and in mediocre or poor condition, and range in size from R = 32 to R = 108 mm. In color they are all dirty yellowish, blotched above with blackish. Few of them have the "palisades" as perfectly developed as in the type, but it is evident in every specimen, even the smallest. It would seem, then, that *phragma* is a Panamic species, and it is most likely that Dr. Jones's specimens were collected at Payta, Peru. No species nearly allied is known from the Hawaiian Islands.

Luidia bellonae.

C. F. Lütken, 1865. Vid. Med. f. 1864, p. 133.

This species reaches, under favorable conditions, a much larger size than has been recorded. Lütken's types were 8 and 12 inches in diameter respectively, which would indicate R = 110–160 mm. Meissner (1896) has recorded specimens from R = 23.5 to R = 232 mm., the last being the largest specimen known hitherto. But in the M. C. Z. collection there is a specimen from Talcahuano, Chile, in which R = 250 mm. and the rays are 45 mm. wide at base. Clearly, then, *bellonae* is one of the largest starfishes known on the west coast of tropical America. The color of dry specimens is like that of many Luidias, gray above, deepest along the middle of each ray, and with more or less of a bluish cast, and white or cream color beneath. Dr. Coker's notes refer to the color of the living animal as simply "gray." This species has a wide distribution, for while Lütken's types (one of them, at least) were from Guayaquil, Verrill (1867) has recorded the species from Callao; de Loriol (1891) from Mazatlan, Mexico; Meissner (1892) from Callao, and (1896) from Iquique and Talcahuano; and Clark (1902) from Albemarle Island, Galapagos. Meissner (1896) expresses the opinion that de Loriol's specimens from Mazatlan were not the true *bellonae*, and he therefore names them *lorioli*. I am not able to agree with this view, for it seems that the characters by which he attempts to separate the two forms are unreliable, and de Loriol's description and figures appear to agree very well with Peruvian specimens.

Dr. Coker took small specimens (R = 100 mm. ±) of this species "off northeast side of San Lorenzo Island" (which is off Callao) in "about 2½ fathoms," on February 5, 1907; and also "with dredge and trawl, Bay of Sechura, west of Matacaballa; about 5 fathoms in depth, April 8," 1907. The Bay of Seehura is just north of Aguja Point. Nothing is recorded of the habits of *bellonae*.

Luidia columbia.

Petalaster columbia J. E. Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 183.
Luida tessellata C. F. Lütken, 1859. Vid. Med. f. 1859, p. 40.
Petalster columbiae A. E. Verrill, 1867. Trans. Conn. Acad., **1**, p. 272.
Luidia colombiae E. Perrier, 1876. Arch. Zool. Exp., **5**, p. 253.
Luidia columbiae W. P. Sladen, 1889. Rept. voy. "Challenger," **30**, p. 247.

Plate 1, figure 2.

This is also a very large starfish, for while most of the known specimens have R = 100–200 mm., there are much larger specimens in the M. C. Z. collection from Magdalena Bay, Lower California. The largest of these has R = 275 mm., and the breadth of the arms at base is 38 mm. The color of preserved specimens is yellowish green, brownish green, or dull greenish gray above, and yellowish beneath. Dr. Coker's field notes show that in life the animal is "dorsally of a mouse color with many dark specks. Below yellowish white." This seems to be one of the most common starfishes of the Panamic region, and one that is widely distributed. It ranges from Magdalena Bay, Lower California, and the Gulf of California to northern Peru, and has also been reported from the Galapagos Islands. Specimens in the Coker collection were taken with *L. bellonae* in the Bay of Sechura, on April 8, 1907, and with *Astropecten erinaceus* at Capon, January 29, 1908. The habits are reported by Coker to be like those of the Astropecten (*q. v.*) with which it is found.

Tosia verrucosa.

Goniodiscus verrucosus R. A. Philippi, 1857. Arch. f. Naturg., **36**, Bd. 1, p. 132.
Pentagonaster (*Astrogonium*) *verrucosus* E. Perrier, 1878. Nouv. Arch. Mus. Hist. Nat., (2) **1**, p. 84.
Gnathaster (?) *verrucosus* W. P. Sladen, 1889. Rept. voy. "Challenger," **30**, p. 750.

To judge from Philippi's account, this starfish would appear to occur not rarely on the coast between Valparaiso and the Rio Maipu, yet strangely enough it does

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[1] This is the way the name has been written for many years, but there is no reason why Gray's original spelling should not be retained.

not seem to have been met with by any other observers. Consequently its real relationships are still very doubtful. Philippi gives the diameter as three inches and the color red. It is not impossible that the species is based upon specimens of the following species, *Odontaster singularis*, but I have never seen individuals of Odontaster answering to Philippi's description.

Odontaster singularis.

Goniodiscus singularis J. Müller and F. Troschel, 1843. Arch. f. Naturg., **9**, Bd. 1, p. 116.
Pentagonaster singularis E. Perrier, 1876. Arch. Zool. Exp, **5**, p. 38.
Gnathaster singularis W. P. Sladen, 1889. Rept. voy. "Challenger," **30**, p. 286.
Asterodon singularis E. Perrier, 1891. Miss. Sci. Cap Horn. Zoöl., **3**, p. K 134.
Odontaster singularis F. J. Bell, 1893. Proc. Zool. Soc. London, p. 262.

Plate 2, figure 4.

The original specimens of this interesting starfish were from Chile, but later investigations have shown that it is a southern species most common on the south and west coasts of Patagonia. It reaches a diameter of 75–80 mm. and in life is red; preserved specimens are dull yellowish or brownish. The only claim which this species has to a place in the Peruvian fauna is based on Leipoldt's (1895) report of a small specimen (less than 30 mm. in diameter) which was taken between Iquique and Pisagua, about 20° S. lat. It is hardly likely that the northern range of Odontaster extends much above the twentieth parallel, so that its occurrence in Peruvian waters is improbable.

Nidorellia armata.

Pentaceros (Nidorellia) armatus J. E. Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 277.
Nidorellia armata A. E. Verrill, 1867. Trans. Conn. Acad., **1**, p. 280.

Plate 4, figure 2.

This is a common and well-known member of the Panamic fauna, ranging from Guaymas, Mexico, to Zorritos, Peru, and also to the Galapagos Islands. The largest specimen seen has R = 88 mm. The proportion R : r is quite variable, ranging from 1.45 : 1 to 1.75 : 1. The number and arrangement of the abactinal spines is exceedingly variable. The color in life is given by Verrill as bright scarlet. Preserved specimens are more or less yellowish or brownish, seldom showing any trace of red. Although this species has been taken as far south as Zorritos, it is not represented in the Coker collection. A specimen in the M. C. Z. collection is remarkable for appearing to have *seven* rays, when seen from above; but when the oral side is examined, it is found that only *five* ambulacral furrows run out from the actinostome; of these, however, two bifurcate, one near the mouth and the other near the distal end, and thus arises the appearance of seven rays.

Oreaster occidentalis.

A. E. Verrill, 1867. Trans. Conn. Acad., **1**, p. 278.

Plate 4, figure 1.

This species is, like the preceding, a common Panamic form, ranging from the Gulf of California southward. The diameter of a large specimen is about 300 mm. Preserved specimens are yellowish or brownish, but in life the dorsal plates are said to be bright crimson, the spaces between greenish brown. Dr. Coker did not meet with this species, nor has it yet been recorded from Peru, but Cuming collected a young Oreaster at Punta Santa Elena, Ecuador, along with Nidorellia, and as it seems almost certain that Oreasters will be found on the northern shores of Peru, I have included the Panamic species in this list. Verrill (1867) has given reasons why Gray's *Pentaceros cumingii*, based on the specimen taken by Cuming at St. Elena, cannot be identical with *Oreaster occidentalis*, but it seems very probable that when our knowledge of the Ecuadorian Oreasters is complete *cumingii* will prove to be the young of *occidentalis*.

Paulia horrida.

J. E. Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 278.

Plate 3, figure 3.

The original specimens of this remarkable starfish were taken by Cuming at Punta Santa Elena, Ecuador, in 12–18 fathoms, in company with Nidorellia and Oreaster. Unlike these latter, however, it has seldom been met with since and seems to be rather rare, the only specimens recorded since Cuming's day being taken at the Galapagos Islands. Gray's type was about 150 mm. in diameter, but the specimens from the Galapagos were smaller. The color of dried specimens is yellowish brown, but in life it is probable the general coloration is red or reddish as in Oreaster and Nidorellia.

Asterina calcarata.

Asteriscus calcaratus E. Perrier, 1869. Ann. Sci. Nat., (5) **12**, p. 292.
Asterina calcarata E. Perrier, 1876. Arch. Zool. Exp., **5**, p. 222.

This species is very little known, the original one (30 mm. in diameter) from Valparaiso remaining unique, so far, at least, as South American specimens are concerned. Under the name *calcaratus* Valenciennes placed a number of Asterinas from Chile, and Gay, in his account (1854) of the echinoderms of that country, made no effort to differentiate them. Perrier, however, restricted the name to this particular form, supposed to be from Valparaiso. Were it not that a variety (*selkirki* Meissner, 1896) is common at Juan Fernandez, one might be doubtful whether Perrier's specimen really came from Chile, especially as de Rochebrune (1881) records *calcarata* from the Cape Verde Islands. For the present, however, we may retain the species in the Chilean fauna, with the hope that further collecting on the South American coast may settle the doubt concerning it.

Asterina chilensis.

Asteriscus chilensis C. F. Lütken, 1859. Vid. Med. f. 1859, p. 61.
Asterina chilensis C. F. Lütken, 1871. Vid. Med. f. 1871, p. 302.

Plate 2, figures 2 and 3.

This pretty starfish, which may be as much as 50 mm. in diameter, is one of the characteristic species of the Chilean fauna, and has been recorded from many places along the coast between Payta, Peru, and Talcahuano, Chile. In the Coker collection there are specimens from La Punta (at Callao), Lobos de Afuera Islands (southwest of Aguja Point) and Bay of Sechura (just north of Aguja Point), but unfortunately there are no notes on coloration or habits. The specimens vary greatly in form, from R = 1.5r to R = 2r and in the spinulation of both the upper and lower surfaces; in some specimens the spinules on the upper side seem rather long, while in others they are more like granules; the plates of the actinal side carry in some cases only 2 or 3 spines, in others 4–6. There is also a striking difference in the color; one group of specimens are uniformly dull yellowish or pale brown, while another shows very bright colors, mingled blue and red. The latter are from the Bay of Sechura and were at first supposed to represent a different species, but unfortunately for that view they do not agree with each other in proportions and spinulation, nor differ consistently in any character but color from the individuals taken south of Aguja Point. It seems therefore that *chilensis* is a variable species, the limits of whose variation have still to be determined.

Parasterina obesa, sp. nov.[1]

Plate 3, figures 1 and 2.

Rays 5. R = 42 mm., r = 14 mm., R = 3r. Interbrachial arcs rounded. Rays very stout, tapering slightly to a blunt point; breadth at base, 13 mm., vertical thickness 10 mm. Disc large and flat, its vertical diameter the same as that of the rays. Whole surface of disc, interbrachial spaces and rays, above and below to the adambulacral series, covered by paxilliform plates very much like those in *Odontaster singularis*, which carry crowded groups of 10–50 blunt, granule-like spinelets. Along sides of rays, and especially on under surface and in interbrachial areas these plates are in regular longitudinal and diagonal series, but dorsally no such regular arrangement is to be seen. Plates in oral interbrachial areas, largest and most widely spaced from each other, with 6–12 spinelets each. Papulae occur singly or in groups of 2–4, between dorsal plates and along sides of rays but not on lower surface. Neither supero- nor inferomarginal plates can be distinguished. Adambulacral armature consists of a marginal series of 3 (rarely 4) stout, blunt spines (about 1 mm. long) of which adoral is usually smallest and aboral largest; surface of plate with half a dozen (4–7) somewhat similar but slightly smaller spines, arranged in pairs or trios. Oral plates small, each with a marginal series of four spines, more or less expanded at tip and a single blunt spine on surface of plate. Madreporic plate very inconspicuous, less than 2 mm. across and only 4–5 mm. from center of disc. Color (dry) uniform, light yellowish brown.

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[1] *obesus*, fat, in allusion to the very plump rays.

There are two specimens of this well-characterized species in the M. C. Z. collection, which were taken at Talcahuano, Chile, by the "Hassler" expedition. I have been in doubt as to their real relationship, but as they are more nearly allied to Sladen's *Patiria bellula* than to any other starfish with which I have compared them, I consider them congeneric with that species. Fisher (1908) has shown that Patiria is untenable and has proposed Parasterina as a substitute.

Phataria unifascialis.

Linckia (Phataria) unifascialis J. E. Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 285.
Phataria unifascialis W. P. Sladen, 1889. Rept. voy. "Challenger," **30**, p. 786.

Plate 5, figure 1.

This common and well-known Panamic species, which ranges as far north as the Gulf of California, has been recorded by Verrill (1867) from Zorritos, Peru, and doubtless occurs on the northern coasts of that country although not met with by Coker. But the record from Timor (v. Martens, 1866, p. 85) is probably based on an erroneous identification, while de Loriol's (1900) specimen from Celebes can scarcely have been collected originally in the East Indies, though it may have been taken to Europe from there. Museum specimens of this species are usually yellowish or grayish in color, but we have no information as to color in life. From the appearance of the best dry specimens, the living animal was probably red of some shade. The largest specimens have R = 125 mm. and also = 9r.

Pharia pyramidata.

Ophidiaster (Pharia) pyramidatus J. E. Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 284.
Pharia pyramidata W. P. Sladen, 1889. Rept. voy. "Challenger," **30**, p. 784.

Plate 5, figure 2.

Like the preceding, this is a common Panamic species, known to range from the Gulf of California to Zorritos, Peru, but not met with by Coker. Leipoldt (1895) records two specimens from Valparaiso, but there is little reason to doubt that, if the specimens are correctly labeled, they were brought to that city from the north. Large specimens of Pharia have R = 150–160 mm. and also = 5.3–7.5r. The color of preserved specimens is dull purplish or reddish brown, often more or less yellowish along the ambulacral furrows. Verrill (1867 p. 288) says that the color is "in life, variegated above with purple and brown," but elsewhere (1871, p. 577) he says, "the dry specimens in best condition are light straw color beneath; the poriferous zones are bright orange; the rows of large plates on the back and sides olive-green; madreporic plate, large, dark olive-green."

Ophidiaster ludwigi.

P. de Loriol, 1900. Revue Suisse Zool., 8, p. 78.

This species is based upon a single specimen in de Loriol's collection, labeled simply "Perou." R = 40 mm., r = 9 mm. Rays, 11 mm. broad and 8 mm. high at base. Color brownish violet; papular areas lighter; ventral side, pale yellowish. While at least one species of Ophidiaster may occur in the warmer coastal waters of Peru, it should be remembered that many animals, described in Europe as from Peru, were really from the island of Peru in the Gilbert group, and it is quite possible therefore that de Loriol's Ophidiaster is not from South America.

Mithrodia bradleyi.

A. E. Verrill, 1867. Trans. Conn. Acad., 1, p. 288.

Plate 6, figure 1.

Although this species was not met with by Dr. Coker and has never been recorded from South America, I include it for two reasons, neither of which alone would warrant such a course. In the first place, it is a Panamic species with the same general distribution as Pharia, Phataria, and others, and therefore will probably be found near Zorritos. In the second place, there is a single dry specimen in the M. C. Z. collection, received in 1862 from the Academy of Natural Sciences of Philadelphia, labeled simply "Arica, Peru." This specimen is of interest because, while it is quite unlike specimens of *bradleyi* from the Gulf of California, it resembles very closely in its general appearance, though not in proportions, the "peculiar specimen" from the Hawaiian Islands, described and figured by Fisher (1906, p. 1096, pl. 37, figs. 2–3). In the Peruvian specimen, R = 135 mm., r = 15 mm., R = 9r and the color is light brown; other dry specimens are nearly black. Fisher (1906) says the rays are usually unequal, and in his largest Hawaiian specimen, R varied from 198 to 230 mm. In life, the color is more or less vermilion red, light or dark or both.

Henricia hyadesi.

***Cribrella hyadesi* E. Perrier, 1891. Miss. Sci. Cap Horn: Zoöl. 3, p. K100.**

Plate 2, figure 5.

This is a species of the far south, which is admitted here on the strength of Meissner's (1896) identification of a number of specimens from Iquique, which is very near the Chile-Peruvian line. It is a small species; in the largest known specimens, R = 41 mm. The color in life is recorded as "ziegelroth oder gelbroth." There is no longer any justification for the use of the name Cribrella, but the name *hyadesi* does not seem to have been used hitherto in combination with the proper generic name, Henricia.

Echinaster cribella.

C. F. Lütken, 1871. Vid. Med. f. 1871, p. 288.

This is another of those unsatisfactory species which has not been met with since it was described. The type was not quite 74 mm. in diameter; nothing is said as to its color. It was supposed to have come from Valparaiso. As Echinaster is a genus characteristic of warm seas, it is quite probable that it occurs on the northern coasts of Peru, but it is hardly to be expected as far south as Valparaiso; yet its distribution may be similar to that of *Asterina chilensis.*

Echinaster cylindricus.

M. Meissner, 1892. Arch. f. Naturg., **58**, bd. 1, p. 184.

This species is based on a single specimen, said to have been taken at Callao, Peru. In this specimen R = 80–90 mm. and also = $7\frac{1}{2}$r. The color is recorded as "dark blackish brown."

Stichaster aurantiacus.

Asterias aurantiacus F. J. F. Meyen, 1834. Reise um die Erde, **1**, p. 222.
Stichaster aurantiacus A. E. Verrill, 1867. Trans. Conn. Acad., **1**, p. 293.

Plate 8, figure 1.

This is one of the characteristic starfishes of the Chilean region. It reaches a large size for a Stichaster, full-grown specimens having R = 120 mm. The color in life is orange or red, but preserved specimens are dull yellowish or pale brown. Specimens have been taken as far north as Callao and as far south as Talcahuano. Dr. Coker met with this species on the rocky shores of the Pescadores Islands and at North Chinca Island. Of the former his notes say, "Abundant; red; brittle," and of the latter, "On rocky shores; color red; easily broken; abundant."

Asterias gelatinosa.

F. J. F. Meyen, 1834. Reise um die Erde, **1**, p. 222.

Plate 6, figure 2.

Although this species has not yet been recorded from north of Iquique, there is good reason to believe it will be found in suitable localities along the southern coast of Peru. It grows to a large size, full-grown specimens having R = 250 mm. and breadth of ray = 50 mm. According to Meyen's original description, the upper surface is milky white, with the spines and tubercles bright orange. Preserved specimens give no hint of such coloration, as they are dull brown of various shades.

Heliaster polybrachius.

H. L. Clark, 1907. Bull. M. C. Z., **51**, p. 54.

Plate 7, figure 1.

This interesting starfish is remarkable for its very limited range, as it is known only from Zorritos, Payta, and the Lobos de Afuera Islands. The number of rays ranges from 31 to 43 and averages rather more than 37. The largest specimen seen is about 180 mm. across. Nothing is recorded of the color in life, but preserved specimens are dull greenish or blackish above, often marked with yellowish blotches; rarely the yellowish predominates; spines and actinal surface yellowish. Two specimens in the Coker collection were taken on the shore rocks of Lobos de Afuera, March 27, 1907.

Heliaster helianthus.

Asterias helianthus J. B. P. Lamarck, 1816. Anim. s. Vert., **2**, p. 558.
Asterias (*Heliaster*) *helianthus* J. E. Gray, 1840. Ann. Mag. Nat. Hist., **6**, p. 179.
Heliaster helianthus F. Dujardin et Hupé, 1862. Hist. Nat. Zooph. Ech., p. 344.

Plate 7, figure 2.

Meyen (1834) speaks of this as the "ausgezeichnetesten" species of starfish and it certainly must always rank as one of the most notable species, because of its large size (300 mm. in diameter) and numerous rays (30–40). It ranges from northern Ecuador (about 2° N. lat.) to Valparaiso, and seems to be very common, as it has been recorded by all collectors on that coast. Dr. Coker took specimens at the Lobos de Afuera Islands, on the northeast side of San Lorenzo Island, at the Pescadores Islands, and at Independencia Bay, south of Pisco. Of the last, he says in his field notes, "white below; above black with spines red." So far as I can discover this is the only observation on the color of a living Heliaster which has ever been recorded, and it shows that the dull shades (blackish and yellowish) of preserved specimens give no clue to the fine coloration of the living starfish.

Brittle-Stars. Ophiuroidea.

The brittle-stars comprise an astonishingly small part of the Peruvian fauna, especially when it is remembered that not less than thirty species occur at Panama, most of which might reasonably be expected to occur as far south as Payta. While lack of attractive reefs and bottoms may account for the absence of some species, it is probable that more intensive collecting will increase the number considerably. The ten species herein recorded represent seven genera, none of which is characteristic of the region; all but one or two are cosmopolitan. Yet, strangely enough, five of the species are not known outside of the Chile-Peruvian region, while four of the remaining five are Panamic. The origin of the ophiuran fauna is unquestionably Panamic; indeed, there is not a single species which seems to have come into the Peruvian fauna from the south, unless *Amphiodia chilensis* is a possible exception.

In referring to the external features of a brittle-star it is customary to speak of the body as the *disc*, and the rays as *arms*. On the sides of the arms, in parallel vertical series, are borne the more or less conspicuous *arm-spines*. On the upper surface of the disc lie the *radial shields*, a pair of plates at the base of each arm; they are sometimes covered by granules or small scales and so appear to be wanting. At the center of the lower surface of the disc is the *mouth*, made up of five radial slits meeting at a common center; between each pair of slits is a triangular or wedge-shaped interradial *jaw*, along the margins of which are the *mouth-papillae;* these papillae show great diversity in size, form, and position, and are of particular importance in classification; in Ophiothrix and some other genera they are quite wanting.

Key to the Brittle-Stars of the Peruvian Coast.

Arms simple and unbranched.
- Disc closely covered with a fine granulation; arm-spines short and appressed . . . . *Ophioderma panamense*
- Disc not granulated but covered with more or less distinct scales; arm-spines not appressed.
  - Disc-scales smooth and free from spines and spinelets.
    - Lower surface of disc (between arms) covered with scales; 3 mouth-papillae on each side of jaw.
      - Outermost mouth-papilla very wide, equalling or exceeding the two inner ones taken together; size small, disc 2–3 mm. in diameter; arm-spines more or less pointed.
        - Disc-scales indistinct even when dry, appearing as though covered by a thin skin; arm-spines wide and very flat; no white spot at outer end of radial shield . . *Amphipholis laevidisca*
        - Disc-scales very distinct; arm-spines slender and sharp; radial shields more or less white at outer end . . . *Amphipholis pugetana*
      - Outermost mouth-papilla not conspicuously wider than the others; size large, disc 5-12 mm. in diameter; arm-spines stout and very blunt.
        - Radial shields large, their length more than one-third radius of disc; disc-scales coarse, fewer than 10 radial series in each interradial area above and only 100–200 scales in each interbrachial space below . . . . *Amphiodia grisea*
        - Radial shields small, their length about one-fourth of radius of disc; disc-scales small, about 15 radial series in each interradial area and 500–1000 scales in each interbrachial space below . . . . *Amphiodia chilensis*

Lower surface of disc naked; jaws narrow with only two papillae on each side, a squarish one at apex and a small one at outer corner; 3 slender, sharp arm-spines . . . . *Hemipholis gracilis*

Disc-scales with more or fewer spines or spinelets, at least near margin.

Disc with only a few spinelets, and these short, smooth, and chiefly near margin of disc; radial shields small . . . . . *Ophiactis kröyeri*

Disc covered with thorny spines or stumps or both; radial shields very large.

Disc with long slender spines and few or no thorny stumps *Ophiothrix magnifica*

Disc with numerous thorny stumps, often with spines also *Ophiothrix spiculata*

Arms dichotomously branched . . . . *Gorgonocephalus panamensis*

Ophioderma panamense.

C. F. Lütken, 1859. Add. ad. Hist. Oph., pt. 2, p. 91.

Plate 8, figure 2.

Although this species has not been recorded from Peru, it is a common Panamic species, and it is not strange therefore that the "Hassler" expedition should have found it at Payta. There is a single specimen from that locality in the M. C. Z. collection. Adult specimens are as much as 25 mm. across the disc, with arms 110–115 mm. long. The color is "greenish gray or brownish, sometimes with a central light spot; arms similar in color, banded with lighter and darker. Lower surface grayish or greenish white" (Verrill).

Amphipholis laevidisca.

H. L. Clark, 1909. Mem. Aust. Mus., **4**, p. 541.

This species was taken by the "Hassler" at Talcahuano and has not been met with since. It closely resembles *A. squamata* and was originally recorded as that species, but seems to be quite distinct. The small size and plain colors render these little brittle-stars so inconspicuous they are ordinarily overlooked. The type is about three millimeters across the disc and has lost whatever color markings it may have had; there is no indication that the outer ends of the radial shields were ever lighter colored than the disc itself.

Amphipholis pugetana.

Amphiura Pugetana T. Lyman, 1868. Proc. Boston Soc. Nat. Hist., **7**, p. 193.
Amphipholis pugetana A. E. Verrill, 1899. Trans. Conn. Acad., **10**, p. 312.

Plate 9, figure 2.

It is only after much hesitation that I have referred to this species, five small specimens, dredged by Dr. Coker in 2½ fathoms off the northeast side of San Lorenzo Island, near Callao, on February 5, 1907. They are certainly Amphipholis, and they are not *A. laevidisca*, but they are not well enough preserved to make it clear whether they are *squamata* or *pugetana*. It seems better, for the present, to consider them the latter.

Amphiodia grisea.

Amphipholis grisea A. Ljungman, 1867. Öfv. Kongl. Vet.-Akad. Förh., **23**, p. 313.
Amphiodia grisea A. E. Verrill, 1899. Trans. Conn. Acad., **10**, p. 313.

No one has met with this species since its original description, which was based on a specimen from Guayaquil, Ecuador. It will probably be found on the northern coast of Peru. The type has the disc 7.3 mm. across and arms 35 mm. long.

Amphiodia chilensis.

Ophiolepis chilensis J. Müller and F. Troschel, 1843. Arch. f. Naturg., **9**, bd. 1, p. 120.
Amphiodia chilensis A. E. Verrill, 1899. Trans. Conn. Acad., **10**, p. 313.

Plate 9, figure 1.

Originally described as from "Chili," this species has since been taken at Talcahuano by the "Hassler" expedition and at Calbuco by Plate. It is probably a southern species and its occurrence on the coast of Peru is doubtful. The adult has the disc 10–12 mm. across, and arms 70–100 mm. long.

Hemipholis gracilis.

A. E. Verrill, 1867. Trans. Conn. Acad., **1**, p. 262.

This is a Panamic species, of which Ljungman had a specimen from Guayaquil; otherwise it is not known from south of Panama. Ljungman (1867) described his specimen as *Hemipholis affinis*, but Verrill's name has about two months' priority and has been generally accepted. In adult specimens the disc is 5–6 mm. across, and the arms 40–50 mm. long. The color is given by Verrill as light greenish gray (in alcohol), the arms banded with whitish; radial shields green; beneath white.

Ophiactis kröyeri.

C. F. Lütken, 1856. Vid. Med. f. 1856, p. 24.

Plate 9, figure 3.

This is the one well-defined, characteristic brittle-star of the Chile-Peruvian region. It has, however, been recorded from the Hawaiian Islands, and if its occurrence there is confirmed, its distribution is very remarkable, for unlike the starfish, *Mithrodia bradleyi*, which also occurs in the Hawaiian group, this Ophiactis is not otherwise known from north of the equator. On the South American coast between Payta, Peru, and Talcahuano, Chile, *kröyeri* appears to be very common. It is a small species, adults being about 6 mm. across the disc, with arms 18–20 mm. long, and the color is inconspicuous, reddish or purplish brown. Dr. Coker found this species off the northeast side of San Lorenzo Island, near Callao; in Ancon Bay, on a muddy bottom, 9 fathoms, and also among shells and sea-weed; and in the Bay of Sechura in 5 fathoms. There are no notes in regard to appearance or habits.

Ophiothrix magnifica.

T. Lyman, 1868. Proc. Boston Soc. Nat. Hist., **7**, p. 254.

Plate 9, figure 4.

This handsome brittle-star is known only from the coast of Peru, between Payta and Callao, and from the Galapagos Islands. It grows to a fairly large size, the disc 10–15 mm. in diameter, the arms 50–75 mm. long. Like most species of the genus the color is more or less variable; in preserved specimens it varies from light gray to dark blue; the radial shields may be mottled with very dark and very light shades, almost black and white, or the inner half of the shield may be dark and the outer half white; in some specimens a longitudinal white stripe on the upper surface of the arm is faintly indicated. Dr. Coker met with this species only in the Bay of Sechura. From a comparison of many specimens of *magnifica* collected at Payta, with a still larger series of the following species (*spiculata*) from a number of localities, I have reached the conclusion that the two forms intergrade so completely that they are probably identical. As such a question can much better be decided from fresh or living material, it has seemed best to keep the two forms separate.

Ophiothrix spiculata.

J. Le Conte, 1851. Proc. Philadelphia Acad. Nat. Sci., **5**, p. 318.

This is a common and wide-spread Panamic species, somewhat smaller than the preceding and more variable in color. Dr. Coker took it in the Bay of Sechura and near Capon, and it has also been taken at Payta and Zorritos. The specimens in the Coker collection from Capon were found living in a sponge, but nothing else is noted as to habits.

Gorgonocephalus panamensis.

Astrophyton panamense A. E. Verrill, 1867. Trans. Conn. Acad., **1**, p. 251.
Gorgonocephalus panamensis T. Lyman, 1882. Rept. voy. "Challenger," **5**, p. 264.

According to Verrill (l. c.), this species ranges from La Paz, Mexico, to Zorritos, Peru, but it was not met with by Dr. Coker. The size of an adult is, disc 35 mm. in diameter, arms 140–150 mm. long. The color of dried specimens is yellowish brown.

Sea-Urchins. Echinoidea.

The sea-urchins rank next to the star-fishes both in number of species found on the Peruvian coast and in number of species characteristic of the region. Several species reach a large size, and at least one (*Strongylocentrotus albus*) is of considerable importance as an article of food. Of the twelve species, five are characteristic of the region, though one of these has been taken at the Galapagos Islands. Six of the remaining species are Panamic forms, while the seventh is characteristic of the southeastern Pacific Islands and its occurrence on the American coast is exceedingly doubtful. The twelve species represent nine genera, six of which occur in the West Indian region, two are characteristically Pacific, and one (*Tetrapygus*) is peculiar to the Peruvian region. With the exception of *Strongylocentrotus albus*, which probably has come up the coast from the south, all of the species have doubtless come from the north, and it is interesting that no fewer than four of them have differentiated into well-characterized forms.

The shell, or more properly *test*, of a sea-urchin to be well examined should be dry, and partly or wholly cleaned from the spines which cover it. It is made up of vertical columns of plates; in all living species there are twenty of these columns, and in most sea-urchins the plates are so firmly united with each other that the test is hard and unyielding. At the upper end of each pair of columns there is a single plate, and these ten plates form in the "regular echini" a ring around the *periproct*, the field in which lies the anus, while in "irregular echini" they form a solid group, the periproct lying outside of them, usually on the lower surface of the test. When the periproct lies outside of them, they form the *abactinal system*, but when the periproct is within, it is also included in the term "abactinal system." Examination of the columns of plates which make up the test will show that these columns are not only arranged in ten pairs, but that the plates of alternate pairs are perforated for the passage of tube-feet; there are thus five double columns of perforated plates (*i. e.* with tube-feet) called the *ambulacra*, and alternating with them five double columns of unperforated plates, the *interambulacra.* The perforations in the ambulacral plates are in pairs and these *pore-pairs* may be arranged in a vertical series on each side of an ambulacrum. Often however they are arranged in oblique arcs of three or more in each plate. In the abactinal system the five plates at the upper ends of the ambulacra are called *oculars* and the five at the ends of the interambulacra, *genitals.* Usually the genitals being larger than the oculars are readily distinguishable by their size, and in the great majority of sea-urchins three or more oculars lie outside the genitals (*i. e.* away from the anus). But the exact arrangement of the plates of the abactinal system shows great diversity in different families and genera. One of the genitals, usually easily distinguished by its larger size, is perforated with numerous small pores. This genital is known as the *madreporic plate.* The ambulacrum at the left side of the madreporic plate is considered *anterior*, *i. e.* it marks the anterior end of the animal. The test itself is more or less fully covered with spines, which are often borne on the abactinal system too; when the spines are large and conspicuous, they are called *primaries;* smaller ones are called *secondaries;* the smallest are *miliaries.* In some flattened Echini the ambulacra on the upper surface are laterally expanded in a conspicuous manner, and from their fancied resemblance to a flower, each is called a *petal.* On the flat, lower surface of some species the ambulacra are indicated by furrows radiating from the mouth, but the pores are exceedingly small and difficult to see. The furrows divide on leaving the mouth and diverge steadily until near the margin of the test, when they abruptly converge and disappear without meeting. These *ambulacral furrows* are concealed by the spines and in most specimens can only be followed on the bare test.

Key to the Sea-Urchins of the Peruvian Coast.

Anus vertically opposite mouth, which is at center of lower surface and provided with jaws and teeth.

Periproct covered by 4 (rarely 5 or even more) approximately equal plates.

Color black or deep purple; numerous secondary spines present *Tetrapygus niger*

General coloration reddish brown; no secondary spines.

Plates of abactinal system and adjoining bare interambulacral areas, so finely granular as to have an almost velvety appearance, prettily marked with deep red in contrast to gray or whitish ground color; usually no ocular plate (sometimes one) reaches periproct . . . . *Arbacia stellata*

Plates of abactinal system and adjoining bare interambulacral areas, coarsely granular, not marked with deep red; one, two, or three ocular plates reach the periproct . . . . *Arbacia spatuligera*

Periproct covered by many small unequal plates.

Test (except the flattened lower side) covered by short, very stout, truncate spines, forming a close, smooth pavement over the whole . . . . *Podophora pedifera*

Test almost completely covered by unequal, more or less elongated and pointed spines.

Test longer than wide, though often only slightly so; color, dark purplish or deep reddish brown . . . . *Echinometra van brunti*

Test with circular outline; color, more or less greenish.

Ambulacra with 4 (rarely 5 or 6) pairs of pores in each arc . . . . *Strongylocentrotus gibbosus*

Ambulacra with 8–10 pairs of pores in each arc *Strongylocentrotus albus*

Anus not vertically opposite mouth, the line connecting them being approximately horizontal.

Test very flat with a deep notch in the margin of each ambulacrum, or a broad slit (*lunule*) formed by the closing of this notch at its outer end; a lunule also in posterior interambulacrum; mouth with jaws and teeth.

Size large, 100 mm. and upwards in length; brown or gray with a purplish tinge; width of area enclosed between two branches of an ambulacral furrow on lower surface, where widest, .40 or more of its length . . . . *Encope micropora*

Size small, rarely exceeding 60 mm. in length.

Anus only 5–6 mm. back of mouth; color deep green *Mellita pacifica*

Anus 9–10 mm. back of mouth; color not green . . *Mellita stokesii*

Test not flat, without lunules or notches; no jaws or teeth.

Size large, up to 70 mm.; test somewhat flattened; some conspicuous primary spines (or tubercles) on upper surface; anterior petals hardly as long as posterior, each containing a somewhat triangular area . . . . *Lovenia cordiformis*

Size small, rarely exceeding 25 mm. in length; test about as high as wide; no conspicuous primaries; anterior petals narrow, more than twice as long as posterior pair. . . . *Agassizia scrobiculata*

Tetrapygus niger.

Echinus niger G. I. Molina, 1782. Saggio St. Nat. Chili, p. 175.
Echinocidaris (*Tetrapygus*) *nigra* L. Agassiz et E. Desor, 1846. Ann. Sci. Nat., **6**. p. 354.
Arbacia nigra A. Agassiz, 1863. Bull. M. C. Z., **1**, p. 20.
Tetrapygus niger A. Agassiz and H. L. Clark, 1908. Mem. M. C. Z., **34**, p. 73.

Plate 10, figure 1.

This is one of the characteristic sea-urchins of the west coast of South America, and may be easily recognized by the very dark color and nearly hemispherical test. It reaches a large size, full-grown specimens being 75 mm. or even more in diameter. It ranges from Payta, Peru, to southern Chile. Dr. Coker met with this species at La Punta, near Callao; on rocks between tide-lines, Feriol Bay near Chimbote; on the rocky shores of the Pescadores Islands, where it was abundant; and at Independencia Bay, south of Pisco, on the rocky shores of Isla Vieja. Of the last, Dr. Coker's notes say: "Black, sometimes with a tinge of violet. Local name 'Gallinazos' or 'Erizos Gallinazos.' 'Gallinazo' is the turkey-buzzard, but the name is also generally applied to the black sea-urchin."

Arbacia stellata.

Echinus stellatus H. D. de Blainville, 1825. Dict. Sci. Nat., **37**, p. 76.
Arbacia stellata J. E. Gray, 1835. Proc. Zool. Soc. London, p. 38.

According to Verrill (1867), this common Panamic species occurs at Payta and Zorritos, Peru, but it was not met with by Dr. Coker. Large specimens may be 60 mm. in diameter, but most individuals are considerably smaller.

Arbacia spatuligera.

Echinus (*Agarites*) *spatuliger* A. Valenciennes, 1846. Voy. Venus Zoophytes, pl. 5, fig. 2.
Arbacia spatuligera A. Agassiz, 1872. Rev. Ech., pt. 1, p. 93.

Plate 10, figure 2.

This characteristic species ranges from Guayaquil to southern Chile. Although not so large as *Tetrapygus niger*, its spines are so much longer (40–45 mm.) that adults (65–70 mm. in diameter) cover a greater area and look fully as large. Dr. Coker met with *spatuligera* at San Lorenzo Island near Callao, and in the Bay of Sechura, about half way between Bayovar and Matacabella, in 5–6 fathoms. There are no notes to show the character of the bottom or the appearance or habits of the living animal.

Podophora pedifera.

Echinus pedifer H. D. de Blainville, 1825. Dict. Sci. Nat., **37**, p. 97.
Podophora pedifera L. Agassiz et E. Desor, 1846. Ann. Sci. Nat., **6**, p. 374.

Plate 11, figure 2.

This remarkable sea-urchin has long been known from the southern Pacific islands and was found common in the Paumotus by the "Albatross" in 1899–1900, "on the seaface of the reef, exposed to the full force of the surf" (A. Agassiz, 1908). Although there are specimens in the M. C. Z. collection labeled "Peru," "Chile," "Callao," and "Valparaiso," no recent collectors have met with Podophora on the American coast and it is highly improbable that it occurs there. Yet it has seemed well to include and figure it, in the hope that some Peruvian or Chilean collector may verify its occurrence or prove its absence.

Echinometra van brunti.

A. Agassiz, 1863. Bull. M. C. Z., **1**, p. 21.

Plate 11, figure 1.

This well-known Panamic species has been reported from Zorritos, Peru, by Verrill (1867), but it was not met with by Dr. Coker. Large specimens may be 75–80 mm. long, with the breadth rather more than nine-tenths as much.

Strongylocentrotus gibbosus.

Echinus (*Toxopneustes*) *gibbosus* L. Agassiz et E. Desor, 1846. Ann. Sci. Nat., **6**, p. 367.
Strongylocentrotus gibbosus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 164.

Plate 12, figure 2.

Among the sea-urchins of South America this species offers the most interesting subjects for investigation owing to the fact that in the very great majority of specimens (in museums at least) the test, and especially the abactinal system, is more or less distorted by the presence of a parasitic crab (*Fabia chilensis* Dana). In specimens of *gibbosus*, less than ten millimeters in diameter, there is no evidence of the presence of the crab; the test is symmetrical and all of the ocular plates are excluded (by the large genitals) from the periproct. In larger specimens, however, the abactinal system shows the effect of the parasite, and in adults the whole periproct and the ring of genital and ocular plates are more or less profoundly modified. The number of ocular plates in contact with the periproct ranges, in adults, from one to five, but as a rule the anterior ocular and the two of the left side are in contact, while the two on the right side are exsert. Very rarely one sees an adult *gibbosus* which appears to be free from the parasite, but even in such specimens it is the left side which has the insert oculars. Among the many questions which arise in connection with this interesting case of symbiosis, are these: Is this symbiosis, with some mutual advantage, or is it pure parasitism? Is it only the urchins in shallow water, near shore, or also individuals in deep water, which are attacked by the crab? At what stage of its own development does the crab enter the urchin? How does it enter and how does it avoid being cast off? Does the presence of the crab cause the ultimate death of its host? Does the crab leave a dead host or does it die too? How does the crab distinguish *gibbosus* from *S. albus* and other Echini?

The adult *gibbosus* may be 60 mm. in diameter, but the great majority of specimens seen are under 50. The green coloration is often modified by red (or reddish brown) tips on the spines. This species seems to be most common in the region between Payta and Callao, but there is a small specimen in the M. C. Z. collection labeled "Valparaiso," and it is probable that the range extends from the Gulf of Guayaquil southwards at least along the shores of northern Chile. Dr. Coker took specimens "with short spines of olive-green color, off northeast side of San Lorenzo Island, in about 2½ fathoms"; others "from the rocks between tide-lines, northeast end of Ferrol Bay, Chimbote, March 1," 1907, where they were "abundant" and had the "spines olive-green, reddish at tips"; others, "olive-green," were "collected from the rocks in two feet of water (at half tide), at Lobos de Afuera, . . . on the bay called 'Independencia.'"

Meissner (1896) makes the rather surprising error of recording this species from Iquique as *Strongylocentrotus albus*; he says all the specimens were more or less deformed by the presence of the crab; the field note quoted calls them "rother seeigel." If it were not for the very full synonymy given, one might regard the error as a slip of the pen; as it is, it is difficult to explain.

Strongylocentrotus albus.

Echinus albus G. I. Molina, 1782. Saggio St. Nat. Chili, p. 175.
Strongylocentrotus albus A. Agassiz, 1872. Rev. Ech., pt. 1, p. 162.

Plate 12, figure 1.

This is the largest of the sea-urchins of the west coast of South America, and of special interest because it is the only echinoderm of that region which serves as food for man. Large specimens may be as much as 120 mm. in diameter. The color is more or less uniformly green, though the tips of the spines may be reddish, or, in young specimens, quite red. The range of *albus* is from Callao to the southern part of Chile. Dr. Coker met with this species at Mollendo, where he says it is "valued as food," and on the rocky shores of Isla Vieja, Independencia Bay, south of Pisco; of these latter he says: "The spines are green; those on the lower part of the sides are reddish; the corona appearing between the spines, deep red or reddish chestnut. These are the edible 'erizos' which are so highly esteemed. This form does not seem to be common north of Independencia. (The forms common at Callao are rarely eaten.)"

Encope micropora.

L. Agassiz, 1841. Mon. Scut., p. 50.

Plate 13, figure 1.

This is a Panamic species ranging from the Gulf of California (Guaymas) to the Galapagos Islands and Peru. It reaches a large size, individuals occasionally exceeding 150 mm. in length. The color is variable, ranging from brown to gray. Dr. Coker took a number of specimens of this Encope "with dredge and trawl — Bay of Sechura — west of Matacaballa; about 5 fathoms in depth. April 8," 1907. These specimens are all more or less rubbed, and are of a light purplish gray color.

Mellita pacifica.

A. E. Verrill, 1867. Trans. Conn. Acad., 1, p. 313.

The type specimen of this interesting form was from Zorritos, Peru, and the species has not been taken elsewhere. The type measured about 55 mm. in length and was a trifle broader. The color of the dried specimen was deep green, but it is quite possible that in life it was red-brown, for the red-brown shades of clypeastroids have the remarkable property of becoming green, especially after death.

Mellita stokesii.

***Encope stokesii* L. Agassiz, 1841. Mon. Scut., p. 59.**
***Mellita stokesii* A. Agassiz, 1872. Rev. Ech., pt 1, p. 141.**

Plate 13, figure 2.

Were it not for the differences shown by the internal structure of the test, I should have no doubt that this is simply the young of *Encope micropora*, but those differences are so striking it is hard to believe they are due to age only. The smallest Encope before me is so much larger than the largest *stokesii* that a fair comparison is not possible and the true relationship of the two forms must remain undetermined. The distribution of *stokesii* is not merely throughout the

Panamic region but extends to the Galapagos Islands. Dr. Coker met with it only in a tide pond at La Boca Grande, Tumbes. These specimens are gray, with an evident purple tinge, and show no trace of the "greenish brown" or "olive" color, to which Verrill (1867) and A. Agassiz (1873) refer. The largest specimen is 63 mm. across, the width slightly exceeding the length.

Lovenia cordiformis.

A. Agassiz, 1872. Bull. M. C. Z., **3**, p. 57.

Plate 13, figure 3.

This is a Panamic species recorded from Guayaquil by Lütken, and although not met with by Dr. Coker it probably occurs on the northern coast of Peru. It is light brown in color, judging from dry specimens, with a decidedly rosy tinge above, especially on the long spines, and yellowish underneath. The test is markedly longer than wide and wider than high; about 50 × 36 × 21 mm. in a fully grown individual.

Agassizia scrobiculata.

A. Valenciennes, 1846. Voy. Venus Zoophytes, pl. 1, fig. 2.

Plate 13, figure 4.

Originally described from Peru, this curious little sea-urchin has since been found throughout the Panamic region. Verrill (1871) gives the measurements of a large specimen as follows: length, 43 mm.; width, 40 mm.; height, 31 mm. The color of preserved specimens is light brown or yellowish gray. Dr. Coker met with this species at Capon, and states that it is common on the mud-flats, where it is known by the local name "Chimpanzas."

Sea-Cucumbers. Holothurioidea.

The holothurians are the least known, and appear to be the least common, of the classes of echinoderms on the Peruvian coast. Although seven species are given in the following list, one is known only from the original description of a specimen labeled "Peru," a second is very unsatisfactorily known from a specimen labeled "Chile" but belonging to a warm-water genus, a third is known from Mexico and from Patagonia and hence is assumed to occur in Peruvian waters, and a fourth is a Panamic species, hitherto very little known. Of the remaining three, two are southern species, which only reach the lower coast of Peru. Consequently there remains only a single common and well-distributed holothurian on the Peruvian coast. In view of these facts it is futile to discuss the origin of the holothurian fauna. It is only necessary to add that the nearest relative of the common Phyllophorus of Peru is apparently some one of the Australasian species.

The more or less elongate body of a holothurian terminates anteriorly in a circle of tentacles surrounding the mouth, but these are very sensitive and highly contractile organs and when the animal is alarmed or irritated, they are withdrawn (or folded) into the anterior end of the body-cavity and the body appears to terminate in a blunt point. Preserved holothurians are usually in this condition unless some artificial means are used to prevent the contraction. The tentacles differ in form in different groups, but among Peruvian holothurians they are either *arborescent, i. e.* irregularly branched from near the base, or *peltate*, *i. e.* the branches are confined to the tip, where they form a more or less flat and circular disk. The body of a holothurian is more or less soft and smooth, but carries, either scattered all over the surface, or confined to five longitudinal areas (the *ambulacra*), little outgrowths or projections which like the tentacles are highly contractile. When these end in a flat sucking disc, they are called *pedicels* or tube-feet, but when more or less pointed, they are *papillae.* Papillae are often borne on large conical elevations called *warts.* The positive identification of holothurians is only possible when the internal anatomy and the calcareous particles in the skin (usually microscopic) are carefully examined.

Key to the Sea-Cucumbers of the Peruvian Coast.

- Tentacles peltate.
  - Body with large warts and conical papillae on the back and sides *Stichopus fuscus*
  - Body without warts but covered by numerous pedicels . . *Holothuria chilensis*
- Tentacles arborescent.
  - Tentacles 20, or sometimes fewer, either equal or more or less unequal in size . . . . *Phyllophorus peruvianus*
  - Tentacles 10.
    - Pedicels arranged in more or less distinct series confined to the ambulacra, at least on the ventral surface.
      - Pedicels in distinct series along the dorsal ambulacra; body elongated as usual in holothurians.
        - Pedicels relatively few in two series along each ambulacrum. . . . . *Cucumaria leonina*
        - Pedicels more numerous, in three or four series along each ambulacrum . . . . *Cucumaria godeffroyi*
      - Pedicels wanting on back, but papillae present; body with ends upturned and thus ascidian-shaped . . . . . . *Colochirus peruanus*
    - Pedicels numerous, irregularly scattered all over body . . . . *Thyone gibber*

Stichopus fuscus.

H. Ludwig, 1874. Arb. Zool.-Zoot. Inst. Würzburg, **2**, p. 21.

This species has been recorded from San Diego, California; Mazatlan, Mexico; Machalilla, Ecuador, and the west coast of Patagonia (see Ludwig, 1898a) and therefore doubtless occurs in the Chile-Peruvian region. It reaches a length of several hundred millimeters and the wart-like papillae of the back may be 5 mm. in diameter at base and 3–4 mm. high. The color in life, of the Ecuadorian specimen, was red.

Holothuria chilensis.

C. Semper, 1868. Reisen im Arch. d. Phil., 2 Th., **1**, 5 heft, p. 249.

Nothing is known of this species beyond what is given in the original description, which was based on a specimen in the Hamburg Museum, labeled "Chile," and even the type specimen is no longer extant. As the genus is characteristic of the tropics and is well represented in the Panamic region, it probably occurs on the coast of Peru, and if the type of *chilensis* really came from Chile, that species is the one we should naturally expect to find. The specimen of *H. vagabunda* in the Stockholm Museum, labeled "Peru" (see Théel, 1886), is doubtless from "Peru" in the Gilbert Islands and not from South America.

Phyllophorus peruvianus.

Holothuria (*Mulleria*, Flemm.) *peruviana* R. P. Lesson, 1830. Cen. Zoöl., p. 124.
Anaperus peruanus F. Troschel, 1846. Arch. f. Naturg., **12**, Bd. 1, p. 61.
Pattalus mollis Selenka, 1868. Zeit. f. w. Zool., **18**, p. 113.
Thyonidium peruanum Semper, 1868. Reisen im Arch. d. Phil., 2 Th., **1**, 2 heft, p. 67.
Thyonidium molle Semper, 1868. *Op. cit.*, 5 heft, p. 243.
Thyone (*Stolus*) *chilensis* Semper, 1868. *Op. cit.*, 5 heft, p. 241.
Pattalus peruvianus Verrill, 1868. Trans. Conn. Acad., **1**, p. 376.
Eucyclus duplicatus Lampert, 1885. Die seewalzen, p. 290.
Phyllophorus chilensis Ludwig, 1887. SB. Akad. Berlin, No. 54, p. 24.
Phyllophorus mollis Ludwig, 1892. Die seewalzen, p. 347.

Plate 14, figure 1.

The above list of synonyms is by no means complete, but is sufficient to show how frequently this holothurian has served as the basis for a new name. This is due, not to any unusual variability, but to the unequal development of its numerous tentacles and to the very great (and usually unequal) contraction they undergo in death. Very few preserved specimens show twenty equally large and symmetrically arranged tentacles; typically ten tentacles are large and ten small, and commonly in such specimens the small tentacles are arranged in five pairs alternating more or less perfectly with the five pairs of large ones; in some specimens the tentacles appear to form two concentric circles. There can be very little doubt that the names given above all refer to the same animal. One of the specimens before me is almost exactly like Lesson's type in that it seems to have but eight tentacles and these are large and about equal; dissection shows, however, the remaining tentacles of very unequal size, strongly contracted and withdrawn into the body. Ludwig (1898 b), while inclined to the view that Lesson's species is identical with Selenka's, thinks Troschel's species and Semper's *Thyone chilensis* are different. He bases his opinion concerning the former on Troschel's statement that anal teeth or at least calcareous anal papillae are present, whereas in *P. peruvianus* there is no trace of them. In view of the individual diversity shown by holothurians in the amount of calcification of the papillae near the anus, I do not think this objection outweighs Troschel's own opinion that his species was identical with Lesson's, and the fact that his having many specimens indicates that the species was the common holothurian of Peru. As regards *chilensis*, Ludwig maintains the separation of Semper's species from Selenka's on the strength of differences in color, calcareous ring, stone-canals and polian vessels. The examination of the specimens in the Coker collection has satisfied me that these differences are not specific, red individuals showing the characters (in their internal anatomy) which ought to go with green color and *vice versa*. Ludwig states that Plate regarded these supposed species as varieties which he designated as "die rothe" and "die grüne"; he found both forms under rocks at Iquique and Cavancha near Iquique. The largest specimen was 200 mm. long, 60 mm. thick. Coker found this species at La Punta, Callao, and north of there at the Pescadores Islands, Ancon, and in the Bay of Ferrol, near Chimbote. The known range is from Payta, Peru, to Talcahuano, Chile. Of the specimens in the Coker collection, those from La Punta are olive-green, those from Pescadores Island reddish purple, one from Bay of Ferrol bright purplish red, and those from "beach drift" at Ancon dull black. They show equal diversity in the structure of the calcareous ring, but the differences do not correlate with either color or locality. It seems to me, therefore, that we have in *Phyllophorus peruvianus* a well-characterized but somewhat variable species, the diverse forms and peculiarities of which offer a most interesting field of investigation to any one so situated that fresh material, especially of growth stages, is available.

Cucumaria leonina.

C. Semper, 1868. Reisen im Arch. d. Phil., 2 Th., **1**, 2 heft, p. 53.

Ludwig (1898 a) has given a full synonymy and an interesting account of this species. Although Semper's type was supposed to come from Singapore, Ludwig thinks the locality was probably wrongly noted, as the species has not been found in the East Indian region since. On the contrary, it is a common species around the southern end of South America, extending eastward to the Falkland Islands and northward on the western coast of the continent to the southern part of Peru. It is usually 30–40 mm. long, but is known to reach a length of 70 mm. The color in life is usually rosy red or clear lake, but may be white tinged with red, and some of those taken by Plate at Calbuco, Chile, are recorded as "im Leben hell gelb."

Cucumaria godeffroyi.

C. Semper, 1868. Reisen im Arch. d. Phil., 2 Th., **1**, 2 heft, p. 53.

This species, originally discovered at Iquique, is now known to range southward, at least as far as Calbuco, and will probably be found on the southern coasts of Peru. It reaches a length of 55 mm., and in life is sulphur-yellow in color. It lives among mussel-shells (Mytilus) and stones in shallow water along shore.

Colochirus peruanus.

C. Semper, 1868. Reisen im Arch. d. Phil., 2 Th., 1, 5 heft, p. 239.

As this species has not been met with since it was described by Semper, there is nothing further to be recorded of it, save that the specimens he had were "yellowish," 15–18 mm. long and 6–7 mm. in diameter. They were recorded as from Peru, but whether it was Peru, South America, or Peru, Gilbert Islands, remains to be shown.

Thyone gibber.

Stolus gibber E. Selenka, 1867. Zeit. f. w. Zool., **17**, p. 356.
Thyone gibber C. Semper, 1868. Reisen im Arch. d. Phil., 2 Th., **1**, 2 heft, p. 66.

Plate 14, figures 2–6.

Selenka's description is very brief and he gives no figures, so that a detailed description and a few figures are desirable, especially as the species does not seem to have been met with since it was described; it is entirely overlooked by Lampert (1885) and omitted from his monograph. The following are the chief characters: —

Tentacles 10, of which the two ventral are very small. Pedicels very numerous, covering all parts of the body. Body wall firm and leathery. Calcareous ring well developed (fig. 2); radial pieces much larger than interradial and with conspicuous posterior prolongations. Polian vessels 3, of which one is very small. Stone-canal single, in the dorsal mesentery; madreporic body elongate, cylindrical, truncate at end and somewhat convolute or spirally wound. Reproductive organs situated *posterior* to the middle of the body, consisting of a tuft of yellowish, unbranched tubules on each side of the mesentery. Alimentary canal and respiratory-trees apparently not peculiar. Anus without calcareous teeth. Calcareous deposits in body wall abundant, in the form of knobbed, perforated buttons (figs. 3, 4) about .09 mm. long; while there is more or less diversity in details and some are not perfectly formed, most of the buttons have 4 large perforations, 10 knobs on the margin (on each surface) and 2 conspicuous, elevated knobs, connected by a thick ridge, in the middle of each surface. There seem to be no other deposits in the body wall. In the pedicels, besides terminal discs, we find that the buttons become elongated into curved supporting rods (figs. 5, 6), without knobs on the margin but flattened and perforated at the ends; the knobs at the middle of the plate disappear on the concave surface, but remain as more or less conspicuous elevations on the convex side. The tentacles are literally packed full of perforated supporting plates and rods; in the tips of the branches these are small and comparable with those in the pedicels, but in the main trunk and its branches they are much larger and are more like elongated perforated plates; while most of them are flat, many are curved and the resemblance to those in the pedicels is occasionally marked. The calcareous particles impart a very considerable rigidity to both body wall and tentacles. The largest specimen before me is 60 mm. long and 20 mm. in diameter, the smallest is only about one-fifth as long. All the specimens agree in color, though the depth of the shades shows considerable diversity. The darkest specimens are nearly or quite black, except for the ventral surface which is more or less whitish, sometimes in very marked contrast. In lighter specimens the dark shade is brown or gray and the ventral surface is yellowish or grayish. In only a few specimens is there a lack of sharp contrast between the upper and under surfaces. As a rule, the anterior part of the lower surface is colored like the back and the tentacles are always very dark.

It is a matter of some interest that Dr. Coker should have met with this Panamic species in Peruvian waters; there seems to be no good reason for doubting that his specimens are identical with Selenka's species. He took two specimens in the Bay of Sechura, in five fathoms, but at the Lobos de Afuera Islands he found this Thyone "very abundant." They were "collected from rocks in two feet of water (at half tide), near 'muello' of Grace & Co., on the bay called 'Independencia' (this little bay to be distinguished from the great bay of 'Independencia' on the coast, south of Pisco)." The color of these specimens in life is noted as "black." It may be added that the nearest relative of this species appears to be *Thyone buccalis* Stimpson of Australia.

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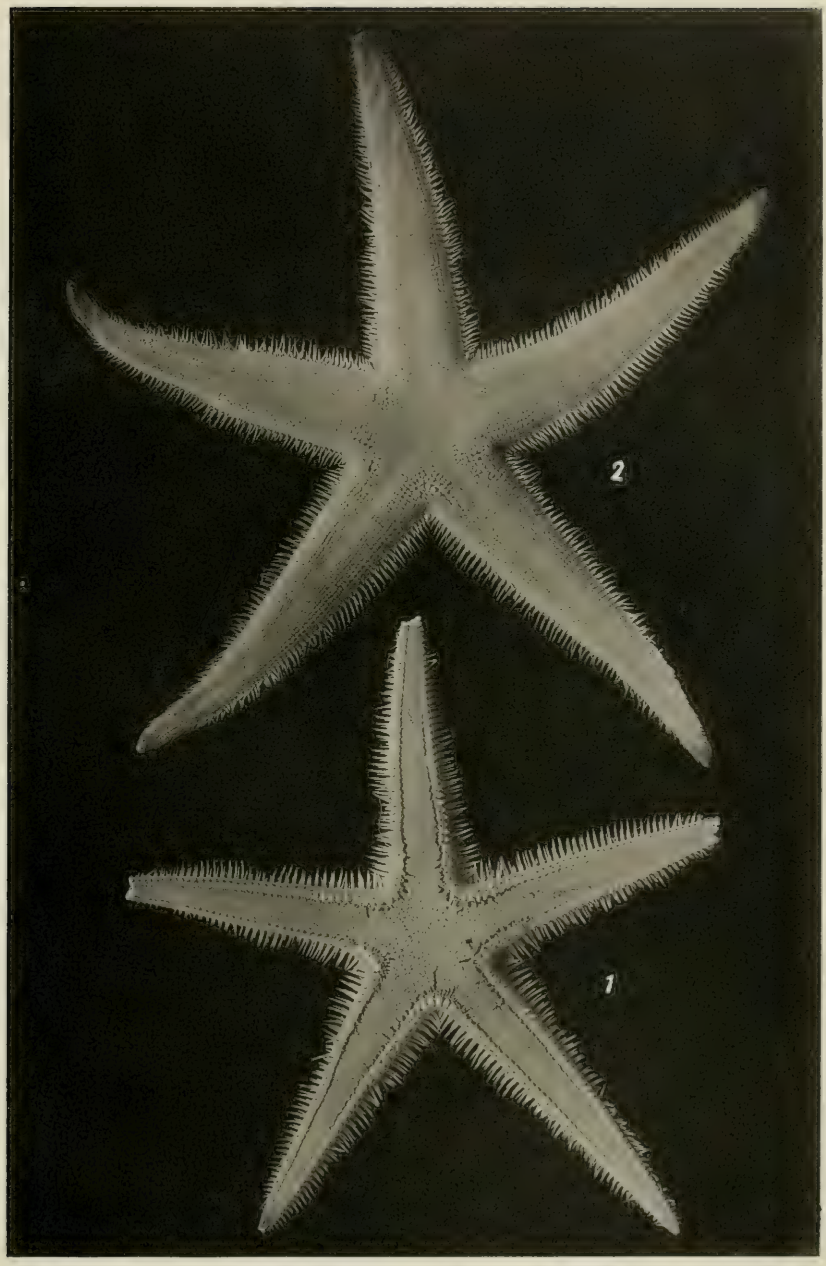
EXPLANATION OF PLATES.

PLATE 1.

Fig. 1. Astropecten erinaceus. Capon, Peru. Upper surface. × $\frac{2}{3}$.
Fig. 2. Luidia columbia. Capon, Peru. Upper surface. × $\frac{2}{3}$.

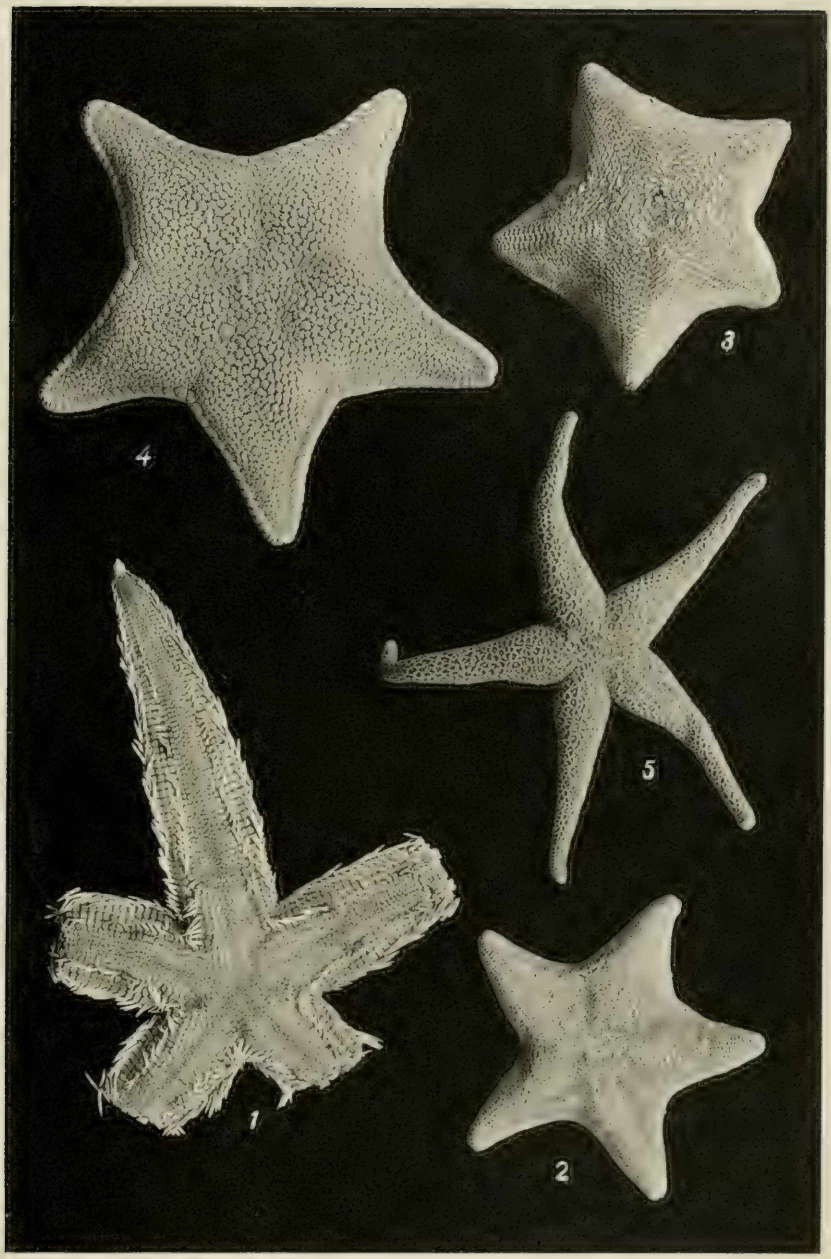


HELIOTYPE CO., BOSTON.

PLATE 2.

Fig. 1. Luidia phragma. Talcahuano, Chile. Upper surface. × $\frac{4}{5}$.
Fig. 2. Asterina chilensis. Bay of Sechura, Peru. Upper surface. × $\frac{4}{5}$
Fig. 3. Asterina chilensis. Lobos de Afuera Islands, Peru. Upper surface. × $\frac{4}{5}$.
Fig. 4. Odontaster singularis. Shoal Bay, Patagonia. Upper surface. × $\frac{4}{5}$.
Fig. 5. Henricia hyadesi. Eastern Patagonia. Upper surface. × $\frac{4}{5}$.

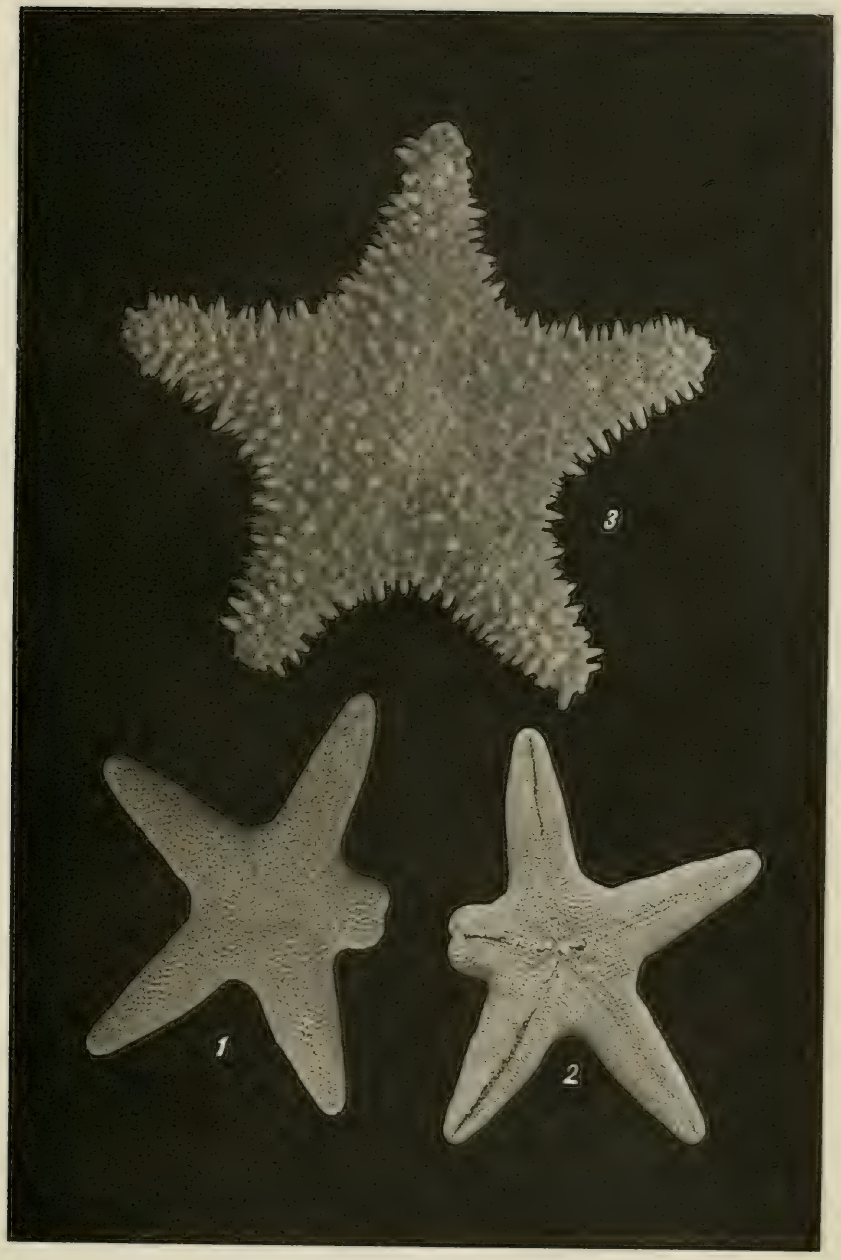
Plate 2.



HELIOTYPE CO., BOSTON

PLATE 3.

Fig. 1. Parasterina obesa. Talcahuano, Chile. Upper surface. × $\frac{2}{3}$.
Fig. 2. Parasterina obesa. Talcahuano, Chile. Lower surface. × $\frac{2}{3}$.
Fig. 3. Paulia horrida. Galapagos Islands. Upper surface. × $\frac{2}{3}$.



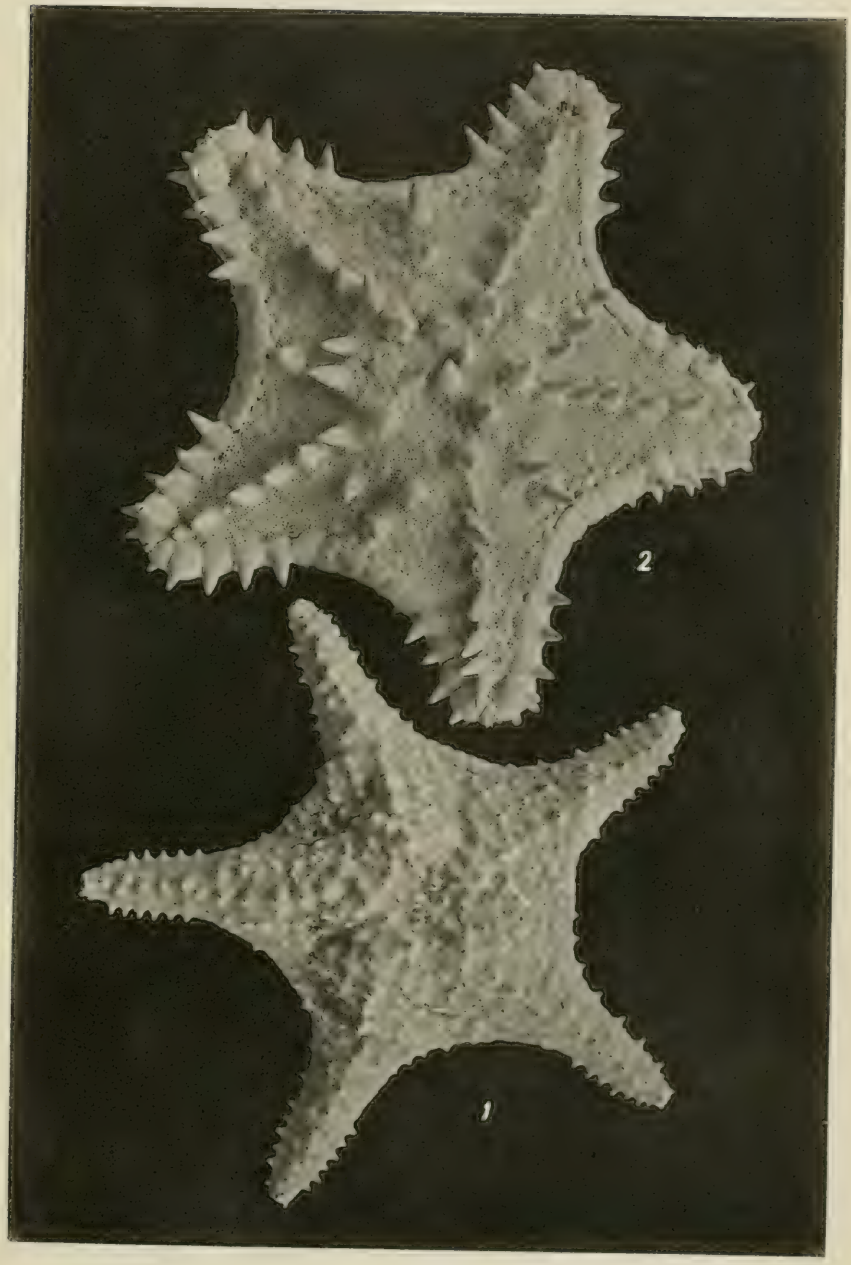
HELIOTYPE CO., BOSTON

PLATE 4.

Fig. 1. Oreaster occidentalis. Lower California. Upper surface. × ½.
Fig. 2. Nidorellia armata. La Paz, Mexico. Upper surface. × ½.

PLATE 5.

Fig. 1. Phataria unifascialis. Acapulco, Mexico? Lower surface. × ½.
Fig. 2. Pharia pyramidata. Acapulco, Mexico? Lower surface. × ½.



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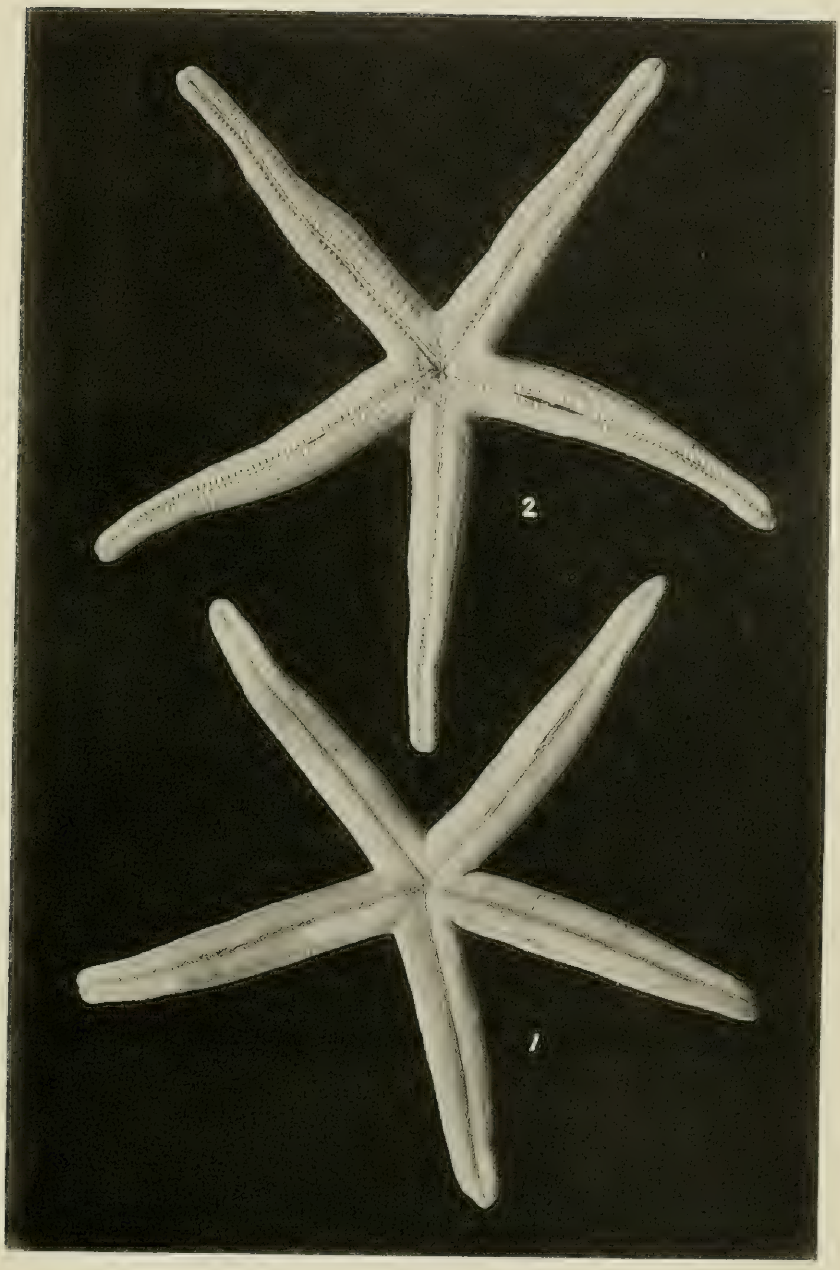
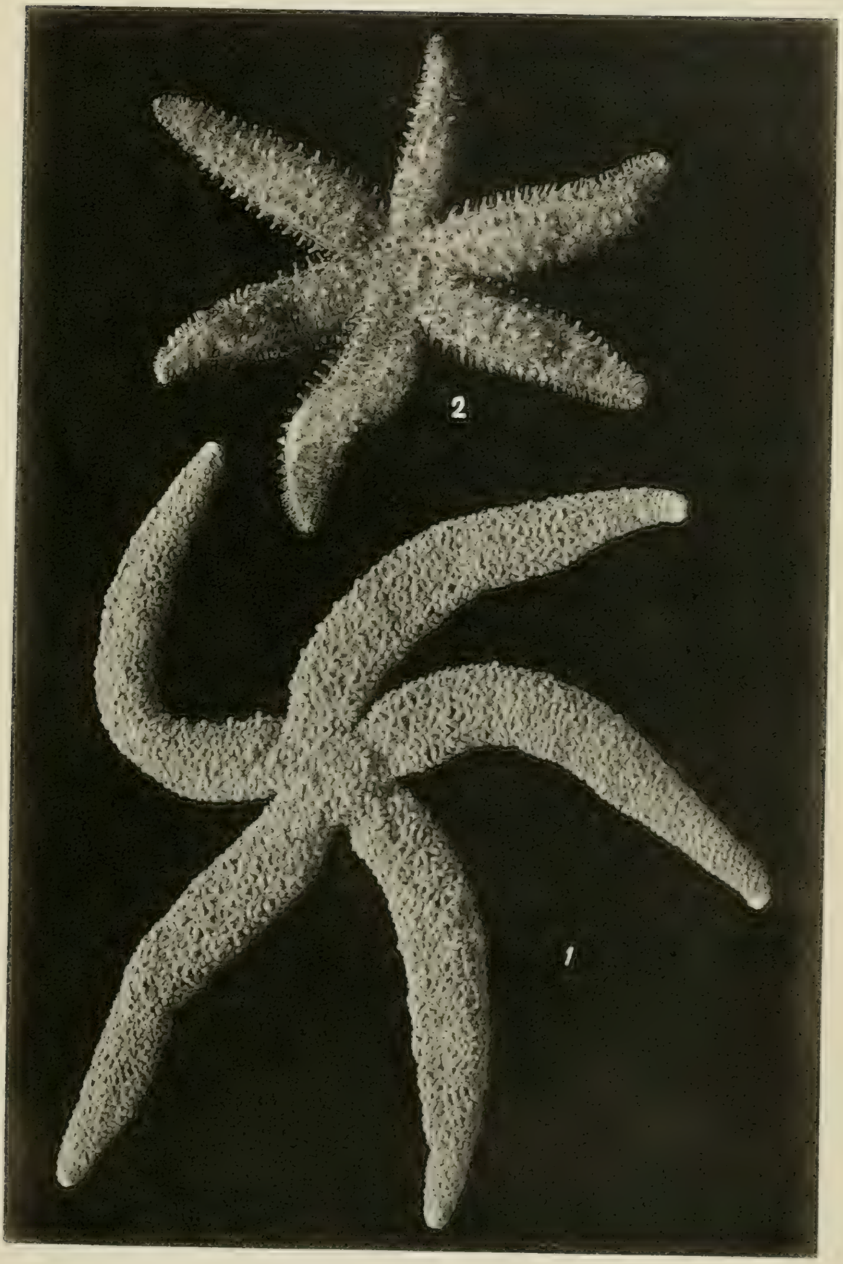


HELIOTYPE CO., BOSTON

PLATE 6.

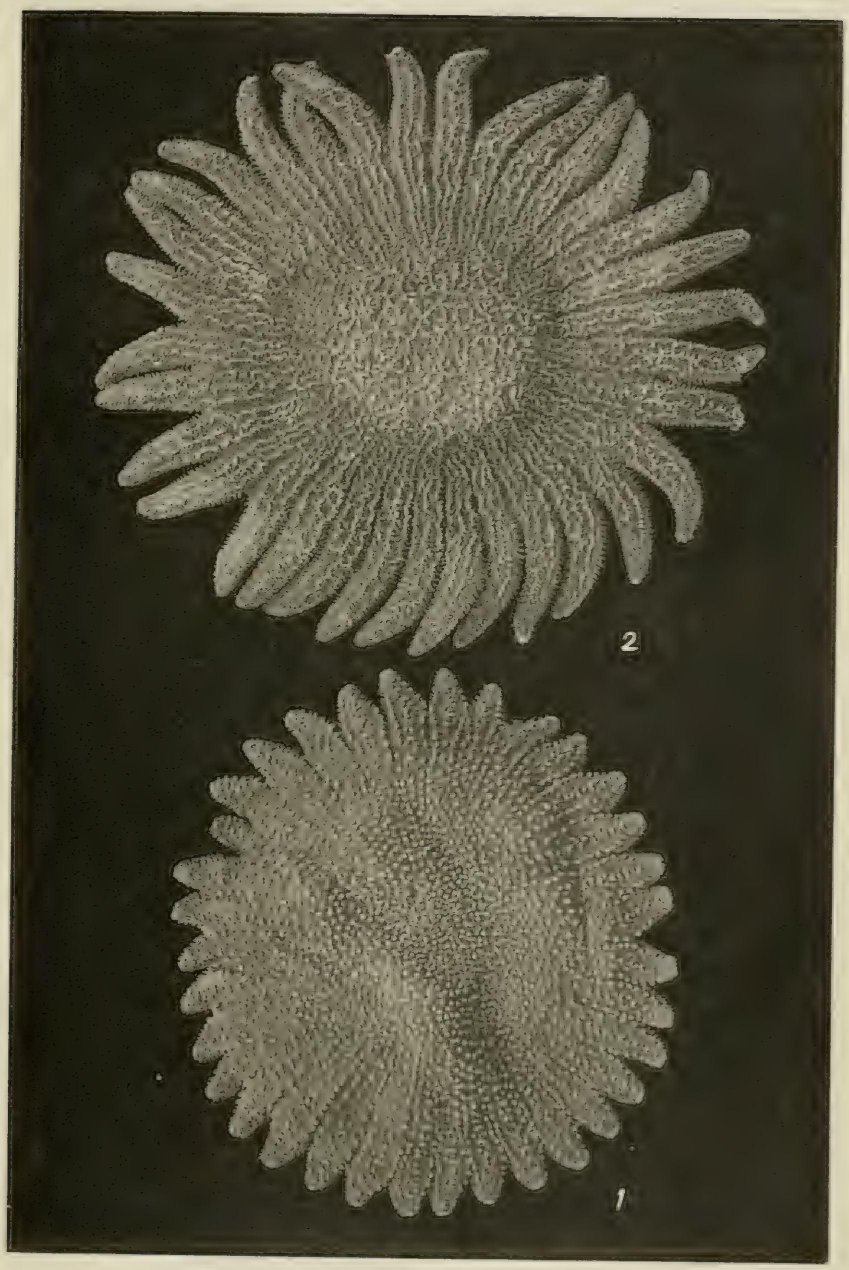
Fig. 1. Mithrodia bradleyi. Arica, Peru? Upper surface. × ½.
Fig. 2. Asterias gelatinosa. Talcahuano, Chile. Upper surface. × ½.



HELIOTYPE CO., BOSTON

PLATE 7.

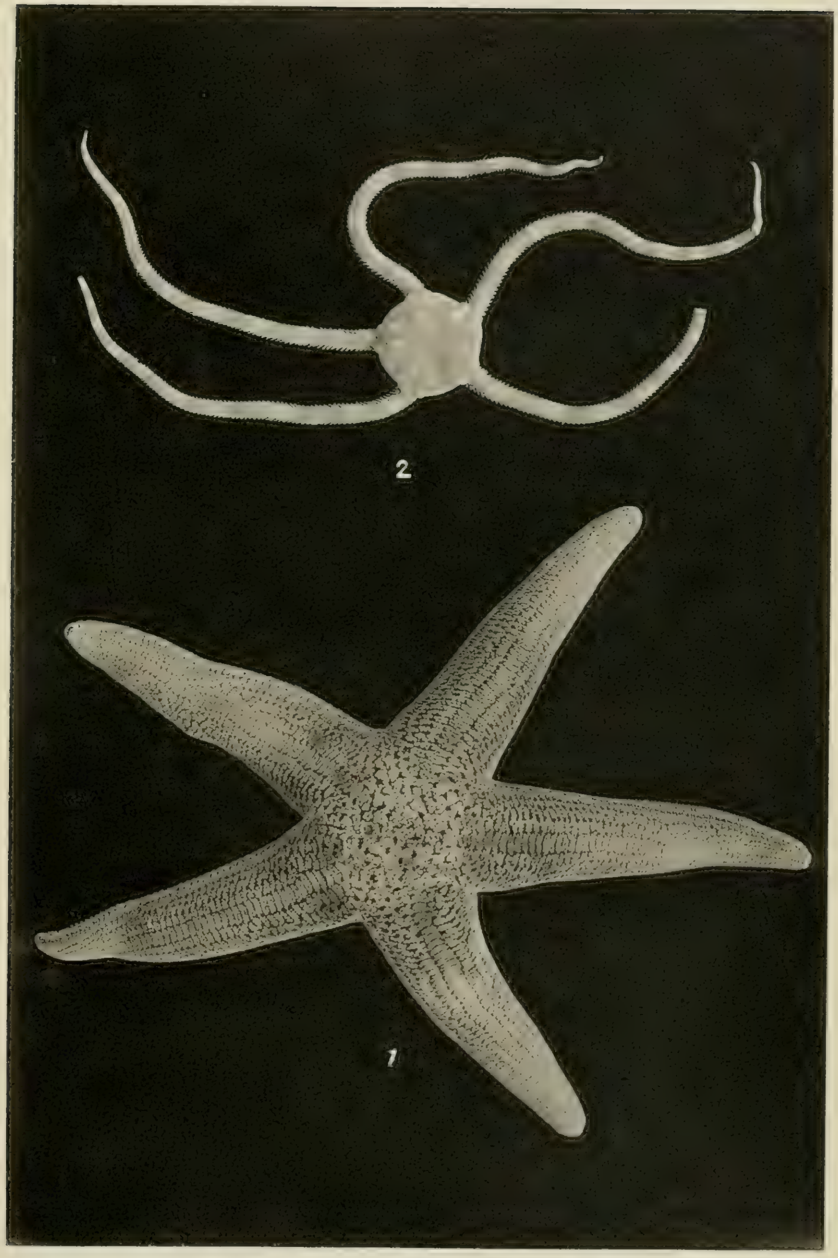
Fig. 1. Heliaster polybrachius. Payta, Peru. Upper surface. × ½.
Fig. 2. Heliaster helianthus. Pescadores Islands, Peru. Upper surface. × ½.



HELIOTYPE CO., BOSTON

PLATE 8.

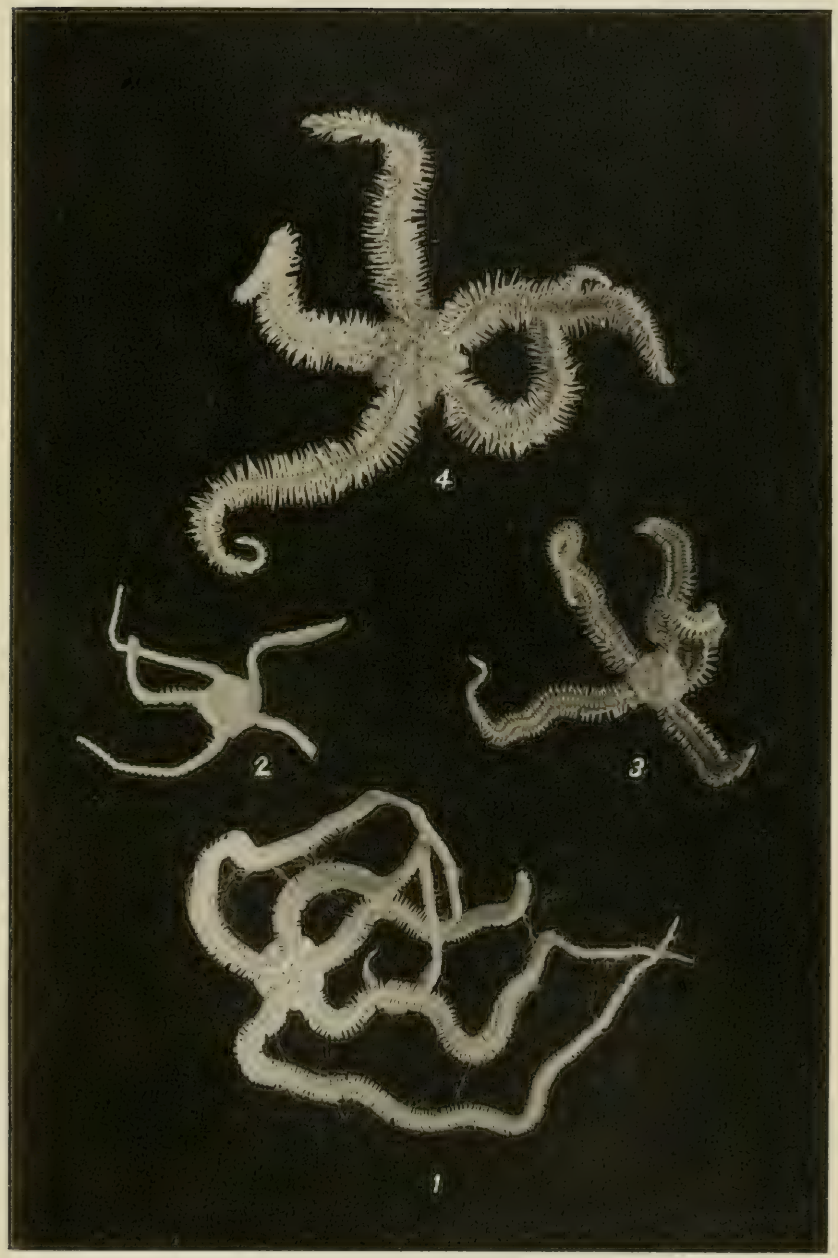
Fig. 1. Stichaster aurantiacus. Caldera, Chile. Upper surface. × ½.
Fig. 2. Ophioderma panamense. Lower California. Upper surface. × ½.



HELIOTYPE CO., BOSTON.

PLATE 9.

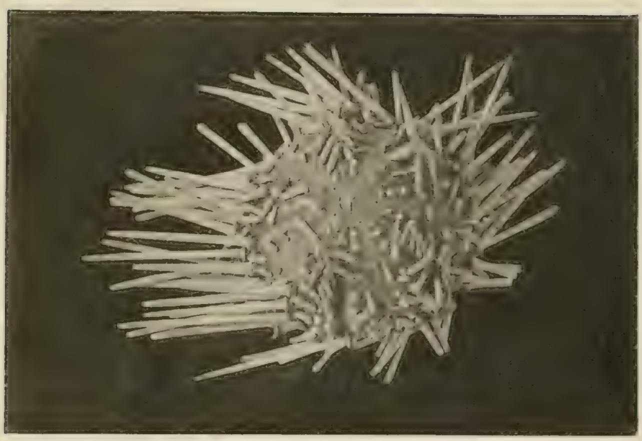
Fig. 1. Amphiodia chilensis. Calbuco, Chile. Lower surface. × 1.3.
Fig. 2. Amphipholis pugetana. San Lorenzo Island, Peru. Upper surface. × 2.5.
Fig. 3. Ophiactis kröyeri. Talcahuano, Chile. Upper surface. × 1.3.
Fig. 4. Ophiothrix magnifica. Payta, Peru. Upper surface. × 1.3.



HELIOTYPE CO., BOSTON

PLATE 10.

Fig. 1. Tetrapygus niger. Talcahuano, Chile. Upper surface. $\times \frac{4}{5}$.
Fig. 2. Arbacia spatuligera. San Lorenzo Island, Peru. Upper surface. $\times \frac{4}{5}$.



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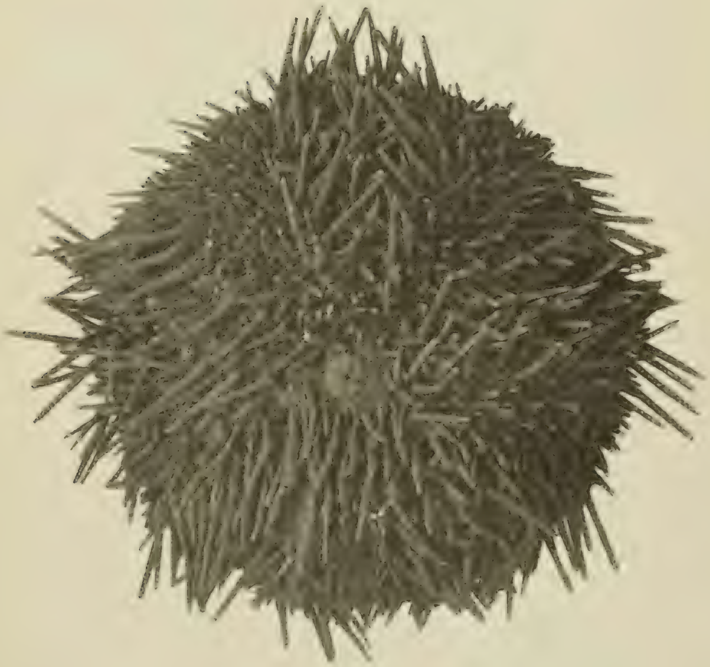

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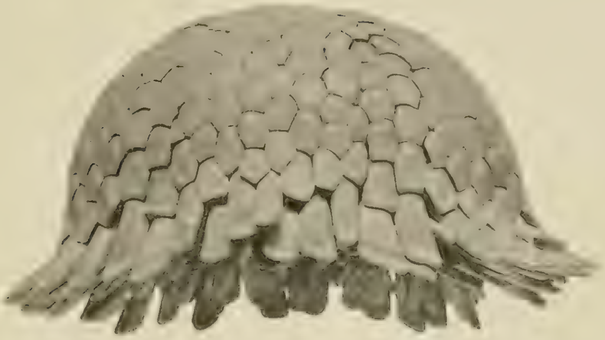
PLATE 11.

Fig. 1. Echinometra van brunti. Mazatlan, Mexico. Upper surface. Nat. size.
Fig. 2. Podophora pedifera. Fakarava, Paumotus. Side view. Nat. size.



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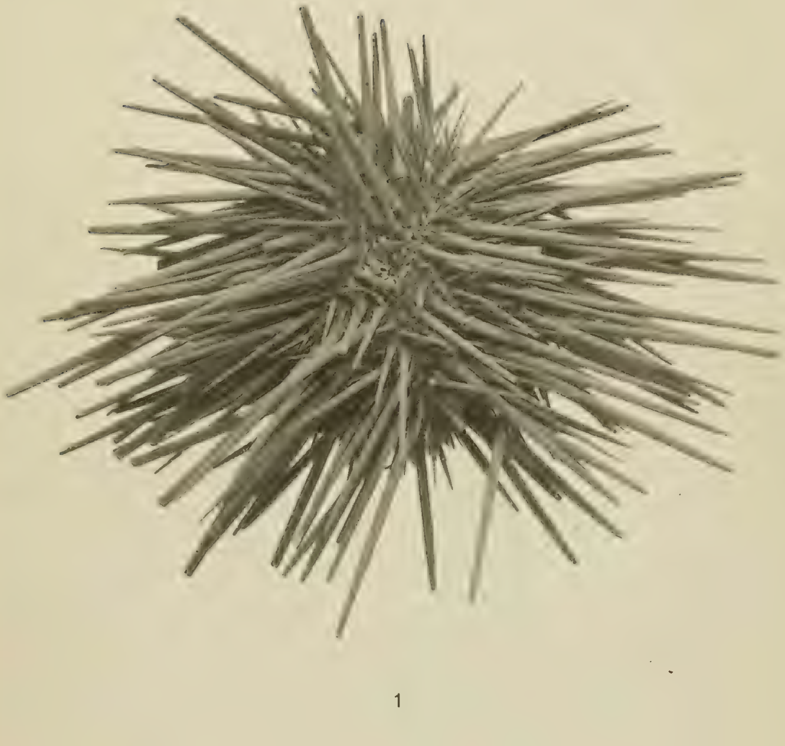

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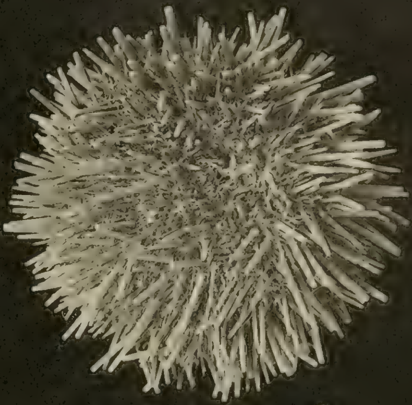
PLATE 12.

Fig. 1. Strongylocentrotus albus. Talcahuano, Chile. Upper surface. Nat. size.
Fig. 2. Strongylocentrotus gibbosus Payta, Peru. Upper surface. Nat. size



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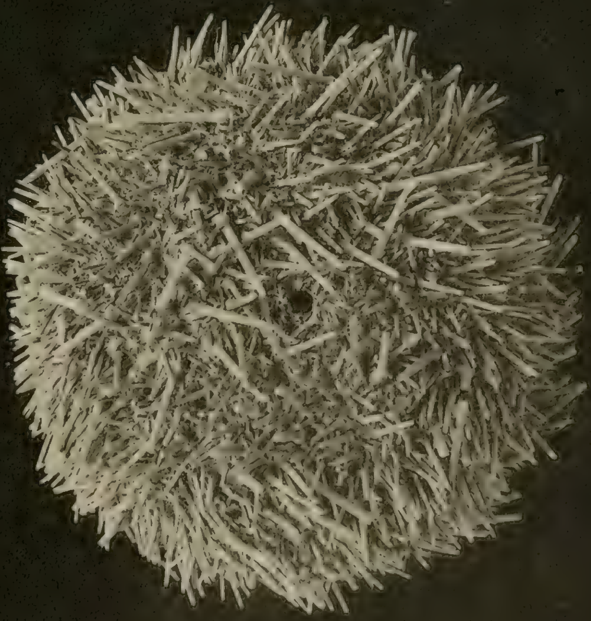

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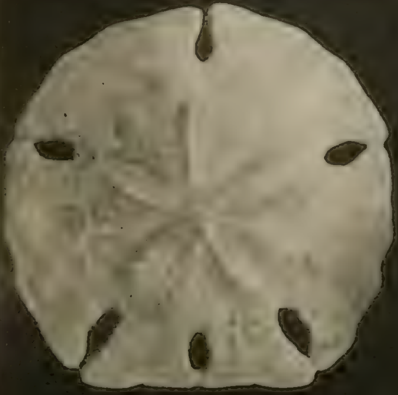
HELIOTYPE CO., BOSTON.

PLATE 13.

Fig. 1 Encope micropora. Bay of Sechura, Peru. Upper surface. × $\frac{4}{5}$.
Fig. 2 Mellita stokesii. Tumbes, Peru. Upper surface. × $\frac{4}{5}$.
Fig. 3 Lovenia cordiformis. San Diego, Cal. Upper surface. × $\frac{4}{5}$.
Fig. 4 Agassizia scrobiculata. Capon, Peru. Side view. × $\frac{4}{5}$.



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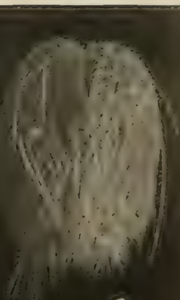

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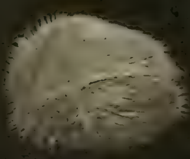

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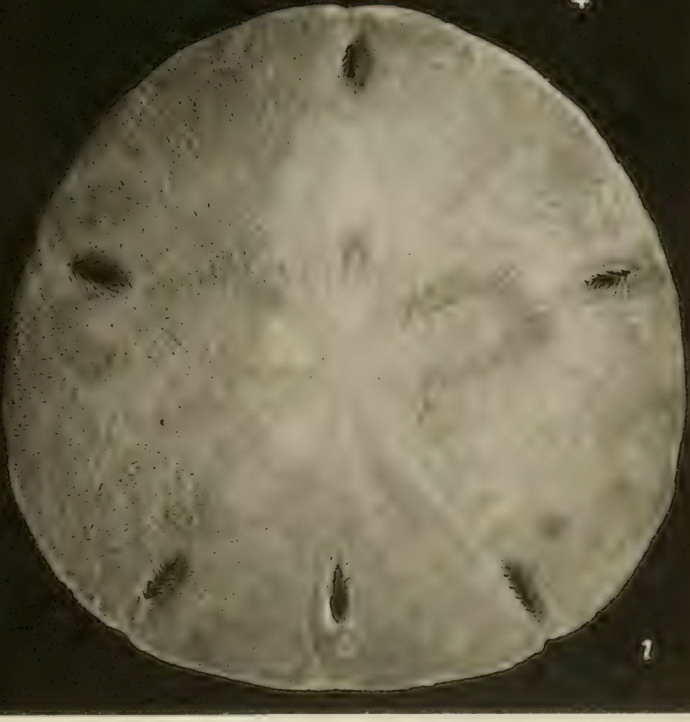

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HELIOTYPE CO., BOSTON

PLATE 14.

Fig. 1. Phyllophorus peruvianus. La Punta, Callao, Peru. Side view. Nat. size.

Fig. 2. Part of calcareous ring of Thyone gibber. Lobos de Afuera Islands, Peru. × 5.

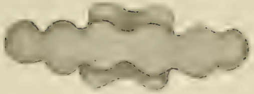
Fig. 3. Calcareous "button" from body wall of Thyone gibber. Lobos de Afuera Islands, Peru. × 450.

Fig. 4. The same as 3, but seen from the side. × 450.

Fig. 5. Calcareous supporting rod of pedicel of same Thyone. × 450.

Fig 6. The same as 5, but seen from the side. × 450.

Plate 14.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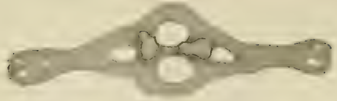
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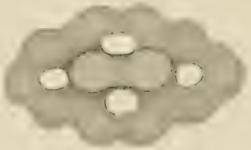
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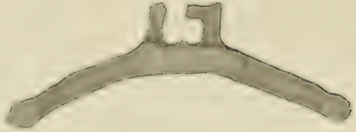
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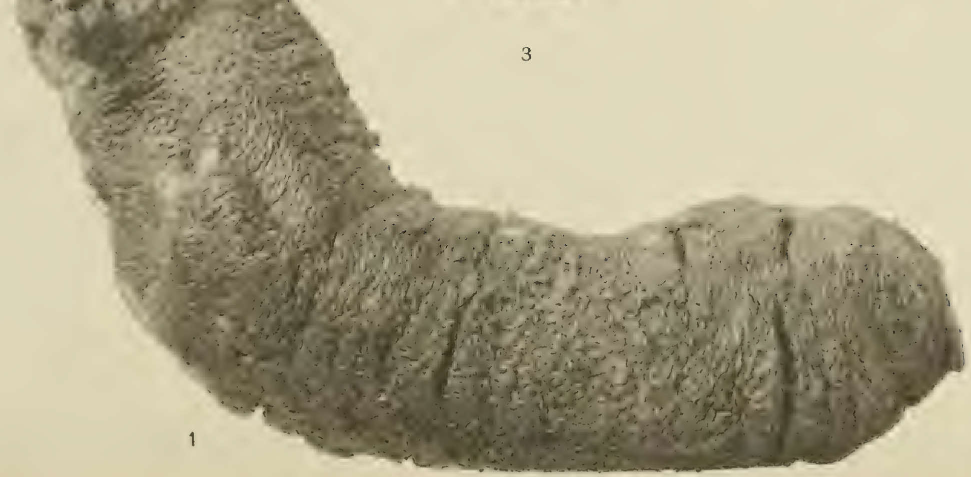
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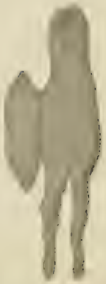
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